metals and alloys

Volume 6 Number 8 August, 1935

The Magazine of Metallurgical Engineering

PRODUCTION FABRICATION TREATMENT APPLICATION

Published Monthly by REINHOLD PUBLISHING CORPORATION, East Stroudsburg, Pa., U. S. A. Ralph Reinhold, President and Treasurer; H. Burton Lowe, Vice President and Secretary; Philip H. Hubbard, Vice President; Francis M. Turner, Vice President. Executive and Editorial Offices, 330 West 42nd Street, New York. Price 40 cents a copy. Annual Subscription: U. S. Possessions, $3.00, Canada $3.50. All Other Countries, $4.00 (Remit by New York Draft).

ARTICLES

LETTER TO THE EDITOR

CURRENT METALLURGICAL ABSTRACTS

HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

Germany Lacks Iron Ore

Germany's serious deficiency of iron ore has led to intense interest in such processes for the utilization of low grade ores as that described by H. Diergarten (page MA 315 L 2).—J.A.

Now Comes Limestone Flotation

A significant advance in the flotation of oxides is marked by the commercial success of limestone flotation (page MA 315 L 6).—J.A.

Non-Ferrous Alloys by Direct Reduction

The possibilities for production of various non-ferrous alloys by direct reduction of oxide mixtures of Ni, Cu, Zr, V, Ta, Nb, W, Mo and Co are discussed by Grassmann & Kohlmeyer (page MA 315 R 8).—A.H.E.

Desulphurization and Alumina in Slags

The relation of Al_2O_3 content of slag to desulphurization is discussed by Joseph and Holbrook (page MA 316 L 7) who have just published some of their results from a laboratory study of desulphurization.—A.H.E.

Flakes

Take your choice of a number of methods of producing steel free from flakes. Acid open-hearth preferred by Zamorujev (page MA 318 R 2).—C.H.H.

More About Nitriding

Once upon a time the action of nitrogen on steel caused a lot of trouble in making ammonia, but later the reaction was turned to a useful purpose. Cast iron for nitriding is discussed by Guillet and Ballay (page MA 321 L 2); the fundamentals of nitriding by Nishigori (page MA 321 L 4); the microstructure of activated and non-activated iron nitride by Natanson (page 321 L 5); the mechanism of the thermal decomposition of these nitrides by Kobosew, Jerofejew and Shichowsky (page MA 321 L 6); and the determination of N in nitrided metals and alloys by Maeda (page MA 321 L 7). It looks like there is a world-wide interest in this subject.—O.E.H.

Passing Oxygen into Molten Metal

It is not often that a metallurgist deliberately introduces oxygen into his molten metal. In the preparation of nickel anodes for electroplating this appears advantageous, however (page MA 328 R 2).—H.S.R.

Gold Foil Still Made as It Was Centuries Ago

Gold foil is one of the extremely rare materials that, so far, has not been improved by modern mechanical methods for speeding up the manufacturing process. The manual process which has been used for centuries is still relied upon for obtaining a superior product. By an electrolytic method, however, gold and other metal foils have been produced of such extreme thinness that they appear transparent to transmitted light (page MA 329 L 2), whereas the best gold foil made in the ordinary way is only translucent. Foil of this kind, however, can hardly compete, from the standpoint of cost with that made by the gold beaten for the usual purposes for which the foil is used.—H.S.R.

Research + Accuracy = Progress

Hruska (page MA 330 R 5) reviews all of the usual testing methods for hardness and includes a table giving comparative figures which are believed to be the most accurate yet assembled.—W.A.T.

Real Data on Rear Axle Gears

Almen and Boegehold presented an outstanding paper on rear axle gears at the June A.S.T.M. meeting (page MA 331 L 3). It's a fine appraisal of the situation in which metallurgical engineering, mechanical engineering and horse sense, or detective ability, were all brought to bear. They conclude that it's a lot more effective to avoid distortion in heat treatment than it is to select a very strong, fatigue resistant material that won't give perfect alignment of the gear teeth.—H.W.G.

Normal Abnormality

Abnormality of steel has been blamed on a variety of things, but none thought of blaming it on purity until several years ago. In many quarters, this suggestion was received with something less than warmth; hence, it is interesting to note that Cornelius (page MA 332 L 7) testifies in favor of the purity school of thought (and, it may be added, for seemingly good reason).—J.S.M.

Constitution of the Fe-Cr-C System

Krivobok reviews the book on plain chromium steels by Greaves (page MA 335 R 2) and appraises the chapter on the constitution of the Fe-Cr-C system as the best existing summary of the subject.—H.W.G.

More About the Low-Alloy Steels

Low-alloy, high-yield strength structural steels get discussion from the points of view of engineering utility and economics. Roberts (page MA 334 R 7) praises "Chromador" and Houdremont and Kallen (page MA 335 L 10) discuss cheap nickel-free steels of this class.—H.W.G.

Ni or Va in Steels for Low Temperatures

Hopkins (page MA 335 L 8) deals with steels for low temperature equipment (—40 deg. F.) Fine grain size obtained by the use of considerable nickel or vanadium is advocated to produce good low temperature impact.—H.W.G.

Nitrogen Explains Difference Between Charcoal and Coke Pig Iron

Myashita (page MA 335 R 6) ascribes the differences between charcoal and coke pig iron to differences in nitrogen content, stating that the strength is almost inversely proportional to nitrogen content. This is a sophomoric type of conclusion, without proof.—H.W.G.

Weathering of Steel a Dangerous Thing at Times

In the extensive report of the British Corrosion Committee (page MA 336 R 3) it is brought out that paint comes off a surface that has been painted when partly weathered so that some mill scale remains, worse than on those that are wholly scale covered or wholly descaled. A little weathering is a dangerous thing. —H.W.G.

The "Thermodynamic Standpoint!"

Don't be scared by the fact that Dr. Johnston's discussion of corrosion (page MA 336 R 6) is from the "thermodynamic standpoint." It is very readable and understandable.—H.W.G.

Wear of Iron Alloys on Emery Paper

Tonn (page MA 336 R 8) discusses the wear of iron alloys on emery paper, but finds that a scratch hardness correlates with the results. What we want to know is, who uses alloys against emery paper in service, and why expect such a test to tell anything about service behavior that wouldn't be predictable from hardness?—H.W.G.

Photographic Prints on Anodic Aluminum

Anodic coatings on aluminum can be sensitized and photographic prints made thereon, says Birett (page MA 340 R 2). —H.W.G.

The Cottrell Precipitator in Europe

Heymann (page MA 342 L 6) gives an extensive discussion of the Cottrell type of electrical precipitator in European practice.—H.W.G.

Several Discussions of Metallurgical History

Metallurgical history is dealt with by several writers. Spencer discusses specifications for cannon in the Revolution (page MA 342 R 6); Richardson, prehistoric iron (page MA 342 R 7); Bergman, silver in ancient times (page MA 342 R 9) and Bassett gives a general discussion of metals in antiquity (page MA 342 R 9).—H.W.G.

The Editorial Advisory Board

(Continued from the July Issue, Page A 17)

A. L. BOEGEHOLD is head of the metallurgical section of the research laboratory of the General Motors Corp., Detroit. After attending the public schools in Mt. Vernon, N. Y., Mr. Boegehold was graduated from Cornell University in 1915 with the degree of M. E. His industrial experience began in that year as a junior engineer with the Remington Arms & Ammunition Co. with which he was associated for about $1\frac{1}{2}$ yr. Following this there were short associations with the Bethlehem Steel Co. in the open-hearth department, with the Fiat Motor Car Co. in the manufacturing end, and with the Bridgeport Brass Co. in the induction furnace melting department.

A. L. BOEGEHOLD

Mr. Boegehold then returned to the Remington company when he initiated his metallurgical training for the next year and a half. This company was then making Browning machine guns and army rifles. When this plant closed at the end of the World War, he joined the Signal Corps of the Army Ordnance Department at Washington, investigating various steels for Browning guns, under the direction of Dr. Burgess of the Bureau of Standards. His next work was with the Remington Arms U. M. C. Co. in the metallurgy of the production of cutlery. In 1920 he joined the research staff of the General Motors organization and assumed his present position in 1925.

P. H. BRACE, an electrometallurgist, is manager of the metallurgical division of the research laboratories of the Westinghouse Electric & Mfg. Co., Pittsburgh. He is a native of Kansas and obtained his early education in the public and the manual training schools of Denver, Colo. He was graduated from the University of Colorado with the degrees of B. S. and E. E., 1909-1913.

The early career of Mr. Brace includes summer positions as a draftsman for the Fritchle Electric Auto Co., and mine electrician, Smuggler-Union Mine, Telluride,

P. H. BRACE

Colo. He joined the Westinghouse organization in 1913 where he successively worked as an engineer on electric furnaces and alloys, metallurgist in the research laboratory, followed by special research work on alloys, and then as section engineer of the research department. In 1929 he assumed his present position. He is the inventor of several products including cobalt magnet steel, metallic calcium, corrosion and heat-resistant alloys, magnetic alloys and thermostatic alloys.

Mr. Brace is the author of numerous papers and is a member of the A.S.T.M., the A.E.S. and the A.I.E.E.

R. A. BULL is a consultant on steel castings, 541 Diversey Parkway, Chicago. He has had a broad experience in steel foundry operations involving such positions as inspector, foreman, superintendent and works manager in foundries using cupolas, crucible furnaces, converters and acid and basic open-hearth furnaces. His executive experience includes the vice-presidency and general managership of steel foundry companies. In an advisory capacity he has been research director for cooperating steel foundries using electric melting furnaces.

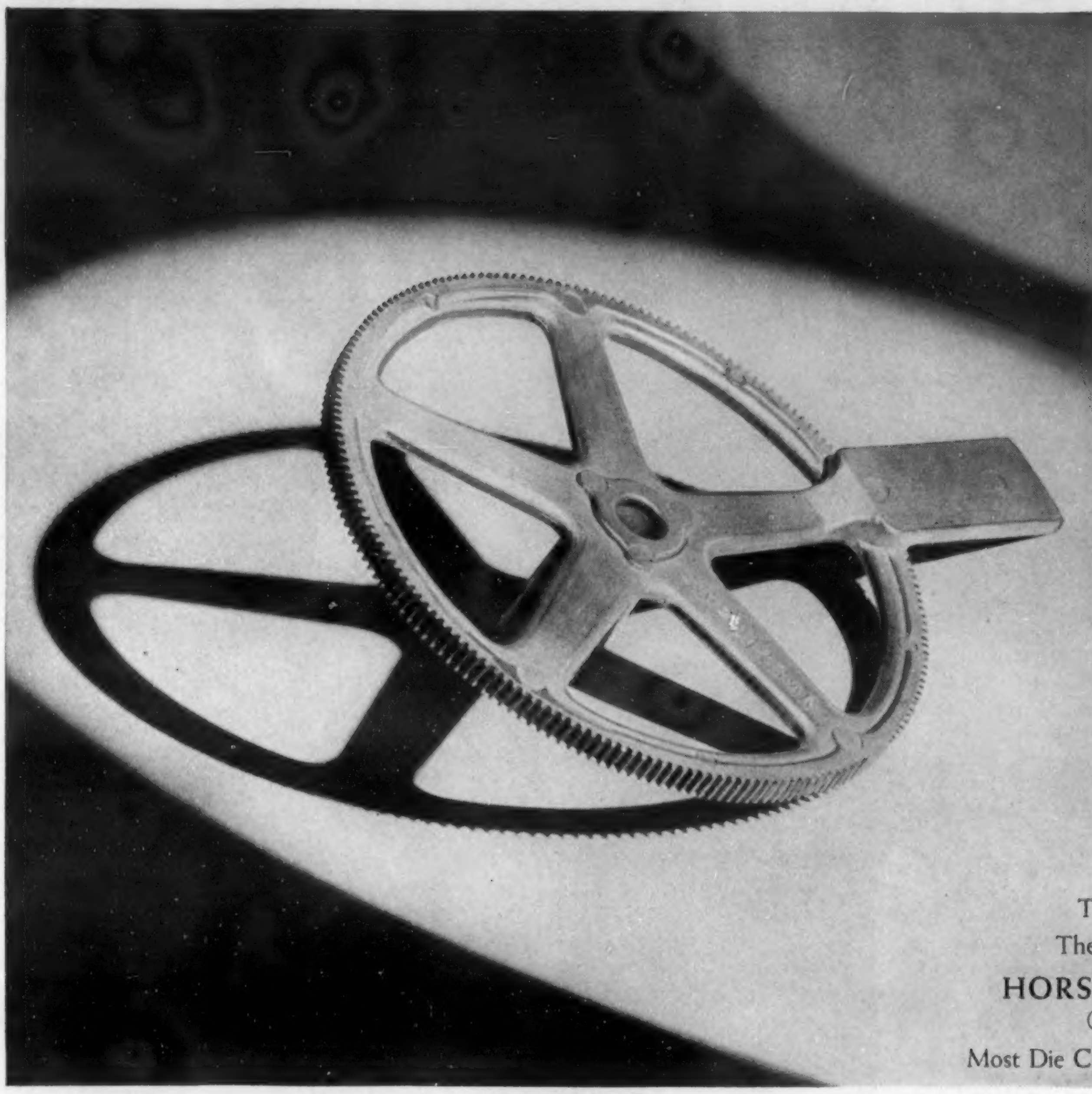
Mr. Bull was graduated from Butler College in 1897, degree of A. B. His M.A. degree was ob-

R. A. BULL

tained from St. Louis University in 1914. He is a member of the Phi Delta Theta fraternity. During the War he was a major in the ordnance department of the U. S. Army, serving solely with the A.E.F.

Major Bull's activities in technical societies have been and are the A.F.A., the A.I.M.M.E., the A.S.T.M., the A.S.M., the Am. Assn. for Advc. of Sci., the Soc. of Mil. Eng., the Army Ordn. Assn. the Am. Soc. of Naval Eng., Iron & Steel Inst. (Brit.), and Inst. of Brit. Fdym. He is a recipient of the Joseph S. Seaman Gold Medal of the A. F. A. for contributions to the foundry industry.

There's Nothing Unusual About This!



The Research was done and
The Alloys were developed with
HORSE HEAD SPECIAL ZINC
(99.99+% Uniform Quality)
Most Die Castings are specified with this metal.

This gear for a measuring instrument is not an unusual ZINC Alloy Die Casting; but it is a precision part. And produced as a die casting much precision milling has been eliminated. Commercial die casters have long been able to produce these jobs; but it is only since the development of alloys with stable properties—certain of the Zamak type alloys—that these precision applications have been wholly successful.

New Jersey Zinc

THE NEW JERSEY ZINC CO.

160 Front Street — New York City

EDITORIAL COMMENT

Wheels and Bearings

IN one of the Ford "Sunday Evening Hours," over the radio last spring, it was stated that five-sixths of the wheels in the world are in the United States, whether they be in clocks, in factories, on the railways, in automobiles or what not.

Each wheel, and each of many other rotating machinery parts, requires a shaft, a bearing, and a lubricant, in order to operate. The bearing problem requires both engineering and materials. There is need for advances in both, but there is especially pressing need for engineering. The *Railway Age* recently stated that during the dust storms in the spring, hot boxes trebled in the afflicted territory as compared with last year, in spite of the fact that trains were halted and the bearings inspected every 50 miles. It was frequently found necessary to re-pack passenger car journal boxes every 100 miles, and to re-brass approximately every 1000 miles.

While these dust conditions were far beyond what is expected in normal service, it is evident that something is radically wrong with the method of sealing the boxes and that grit in the bearings probably plays a larger part in normal wear than had been thought. A redesign seems called for.

Engineering has been forced upon the makers of ball, roller and needle bearings for the contact loads required by the design are so high that each size of bearing has a definite limit of loading and in self-protection the makers must set up load limits for each size and to manufacture sizes for each load range, so that a considerable degree of standardization has resulted. From the material angle, the maker is limited to heat-treated steel, usually alloyed, for he knows that no weaker material will stand the gaff.

So the metallurgy of such bearings resolves itself into a fairly limited field of rather standardized materials and into painstaking effort to secure cleanliness and uniformity in the steel, in order to avoid breakage of any tiny part of the unit, which would ruin the whole. Precision machine work is essential because there are so many parts in such bearings so the whole industry is precision-minded in dealing with everything from raw materials to finished product.

The sleeve bearings, which far outnumber the ball and roller types, are very much farther from standardization because there are so many possible types of materials available. Shafts range from soft machinery steel up through the cast, malleablized and heat-treated Ford crankshaft type, hardened steel and carburized steel, up to the hardest nitrided steel. Bearings range from pure lead, once used in railway bearing liners, up through lead base babbitts hardened in various ways, including the use of alkali metals; the old reliable tin-base babbitts, soft and hard; zinc-base alloys; cadmium-base alloys; the copper-lead family; cast iron; soft bronzes on up to the hardest high tin, high phosphorus bronze. All of these have many modifications and still other types of alloys not mentioned are used or have possibilities.

The stronger alloys may be used as solid bushings or as linings and the weaker ones as linings upon thick or thin, bronze, steel, or other backings. Each type of bushing or lined bearing will have a certain limit of deformation, coefficient of expansion, modulus of elasticity, behavior at operating temperatures, ability to hold lubricant on its surface, etc. Each can be made of varying grain size and hardness according to the method of casting, and, in the case of lined bearings, great differences in perfection of bonding to the back may be found. Then, too, many types can be made solid, or, by the use of powdered metals, can be made porous for bodily retention of oil.

With such a variety of possible variations in properties in available materials, it would seem high time for the engineer to start to define what he wants in a bearing in terms of measurable properties, such as modulus, coefficient of expansion and the like. Instead, the problem is usually stated in relation to some previously used type of bearing metal, e.g., a material like babbitt but with higher strength at high temperatures may be called for, and the properties of a new bearing metal are often evaluated in the laboratory by tests that have little or no relation to the service ability of a bearing.

The user may want "conformability," but how much and how it should be measured is not clear. One feels it to be plausible that a new alloy is a bearing metal if it has a duplex structure, yet even that is in dispute and the explanations for such a requirement are not consistent.

The problem is further complicated by the fact that engineers are not in agreement as to the proper viscosity of an oil for a given purpose nor as to the importance of "oiliness," the ability to maintain a film between shaft and bearing while at rest. In the search for cheaper refining methods and larger fields of lubricating oils from the crude stock, and in the desire to improve quality by eliminating some classes of compounds thought to be impurities, new refining methods are installed. Additions are made to produce "oiliness" in oils which are deficient in natural film-forming constituents. Then it is found that some of these additions, and oxidation products that form in some oils under operating temperatures, are corrosive to some of the newer bearing metals which will stand up at high temperatures.

Questions then arise how to eliminate such corrosive oils from the market, how to produce new bearing metals that will not be corroded by the active oils, or how to alter engine design so as to keep the temperature down low enough so that the old standard metals, that are not corroded, will not squeeze out. Which line of attack is the best and cheapest is not yet clear. Nor, in the case of any particular type of bearing metal are the actual causes of failure in severe service definitely known. When a lined bearing cracks up, one engineer will lay it to poor bonding, another to fatigue breakdown, and so on.

Plenty of people are convinced of the importance

(Continued on page 208)

Controlled Atmospheres in Steel Treating—I

A Correlated Abstract

By H. W. GILLETT

Editorial Director of METALS & ALLOYS *and Chief Technical Advisor, Battelle Memorial Institute, Columbus, Ohio.*

Acknowledgements

A PRELIMINARY draft of this correlated abstract was sent to many users and makers of controlled atmospheres for comment. Their very helpful suggestions were freely utilized in revision.

Among those to whom grateful acknowledgment is due for such assistance are:

H. A. Anderson
J. B. Austin
D. H. Bacon
T. F. Baily
J. F. T. Berliner
A. L. Boegehold
E. F. Burke
H. B. Chambers
H. A. Clark
J. H. Critchett
P. B. Crocker
R. J. Cowan
J. A. Doyle
J. A. Dow
H. J. French
T. S. Fuller
L. R. Garretson
W. A. Gatward
J. P. Gill
E. Hauser
N. W. Hartz
C. E. Hawke
Wm. Hepburn
A. H. Heyroth
J. E. Hines
W. E. Jominy
A. B. Kinzel
J. B. Johnson
John Johnston
J. M. Lednum
J. M. Lohr
R. L. Manier
F. L. Meacham
M. H. Mawhinney
D. W. Murphy
W. F. McGarrity
A. H. Oberdorfer
S. K. Oliver
T. Patterson
G. A. Reinhardt
F. J. Ryan
C. B. Sadtler
H. A. Schwartz
F. N. Speller
A. M. Steever
J. A. Stein
A. J. Strain
Jerome Strauss
S. Tour
R. D. Van Nordstrand
N. A. Ziegler

THE ATMOSPHERE THAT nature gives us is useful to the heat-treater in providing oxygen for combustion of fuel to generate heat, but the oxygen also wants to burn up hot steel. Thus it becomes necessary for the heat-treater to circumvent nature if he doesn't want to let the surface of his steel scale away. In preventing scaling by providing other atmospheres than air, he runs up against other phenomena, such as decarburization, that may be equally undesirable. To dodge between the difficulties and keep the surface of the steel unchanged, or to change it as he desires, requires the application of a good deal of chemistry and engineering.

Much has been found out about the reactions between hot, solid, steel surfaces and different gases and mixtures of gases, and some of this information has

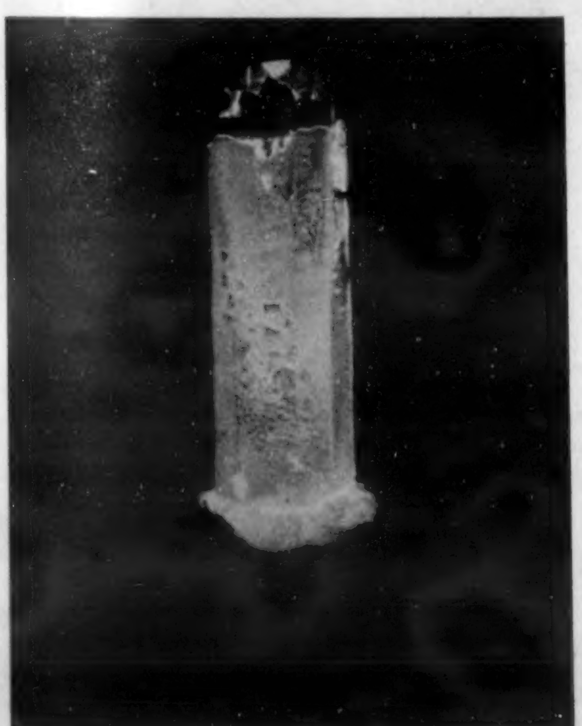


Fig. 1. Ni-Cr Steel Ingot Coming from Soaking Pit Heated with Coke Oven Gas, Heavily Scaled.

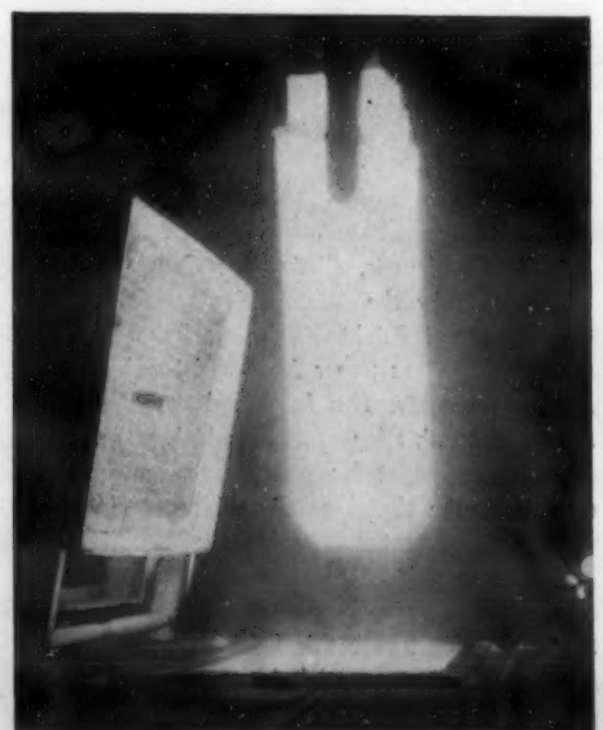


Fig. 2. Ni-Cr Steel Ingot Coming from Soaking Pit Heated by a Baily Granular Carbon Resistor, Atm sphere High in CO, Lightly Scaled.

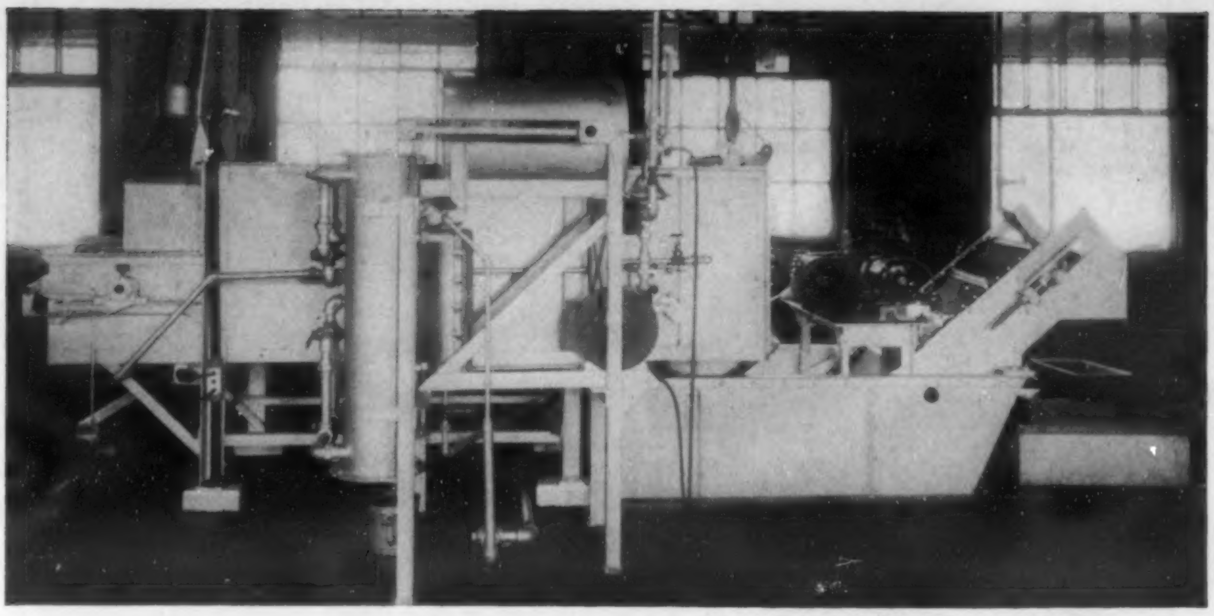


Fig. 3. Gas-Fired Continuous Furnace for Scale-Free Hardening under Controlled Atmosphere. W. S. Rockwell Co.

been engineered into ingenious and useful heat-treating furnaces, many of which have been described in the technical press.

Such descriptions are usually quite specific, relating to a particular make of furnace for a particular service, rather than viewing each one as a member of a large family. The studies of the chemistry of the attack of gases upon the surface of hot steel are likewise usually quite specific and are aimed to elucidate some particular problem.

As one commentator puts it, "practically nothing has been published about what is being done in plants using controlled atmosphere furnaces, except the usual sales papers showing the beautiful furnaces—fore and aft—that have been installed at the plant of the Gimmick Motor Co. by the Unrestrained Furnace Co."

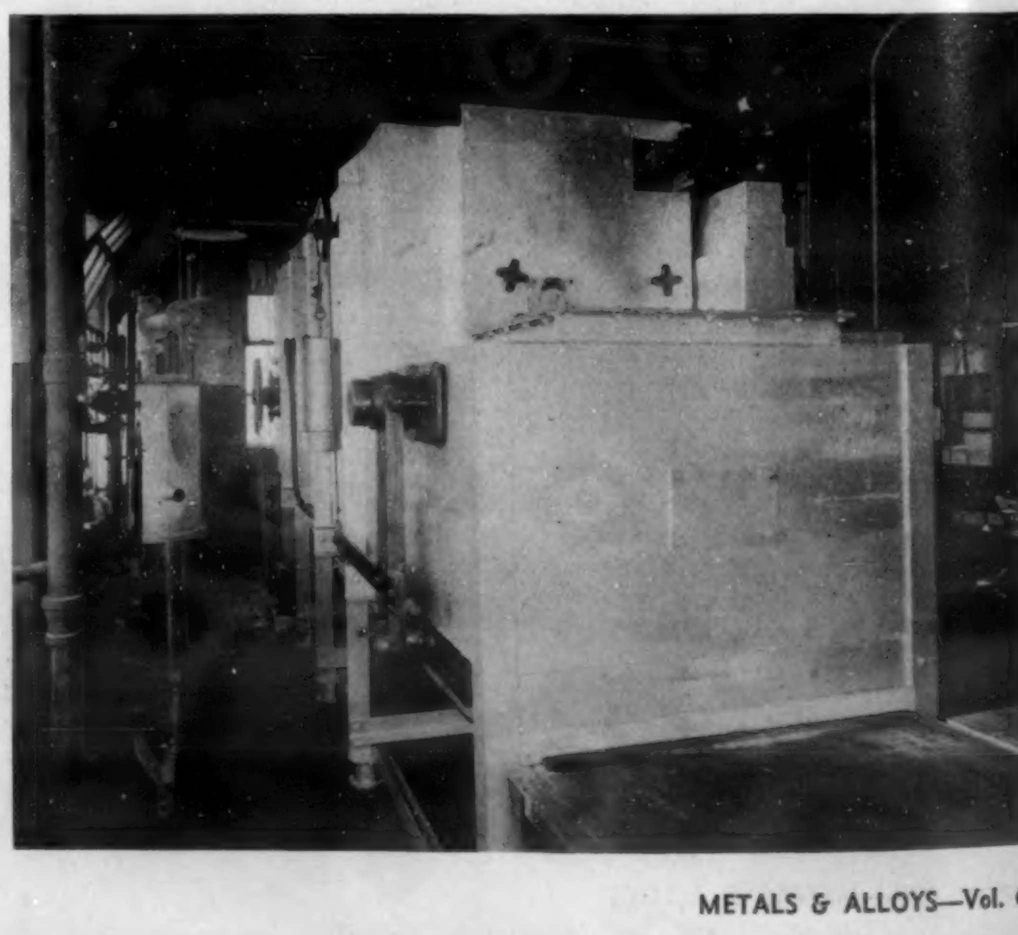
Thus it seems of interest to try to link together some of the published information on gas-steel reactions and methods for controlling them. In so doing we shall confine ourselves to those cases where the steel is solid and the atmosphere is adjusted. This eliminates such subjects as the effect of gases upon molten metals, welding in selected atmospheres, nitriding (where the atmosphere is fixed, since it must be one containing nascent nitrogen), the attack upon steel containers in nitrogen fixation and the like, and the problems of bright annealing of brass and other non-ferrous alloys.

Even with the exclusion of all these important topics, we have left an extremely wide field, and to narrow it a bit more, we shall further exclude those complications that arise from alloying the steel. Thus, aside from some comment on high-speed steel, only plain carbon steels will be considered. We shall assume that variation in Si, Mn, S and P, in a plain carbon steel, and the amount of residual alloying elements such as Cu, Ni and Cr from scrap, are too small to affect the reactions, nor shall we worry about the effect of differences in grain size, methods of deoxidation, etc., that might make two steels of identical carbon content act differently.

Like most simplifying assumptions, these assumptions would not be justified in a more minute study of the problem. D. W. Murphy (personal communication) states that melting practice affects scaling, for rimming steels scale more rapidly than killed steels, and that grain size affects decarburization.* Zingg and coworkers[1] also find that decarburization is affected by the "purity" of the steel, probably

* This will be discussed in a paper, "Grain Size and Its Influence on Surface Decarburization," by D. H. Rowland and C. Upthegrove, to be presented at the 1935 meeting of the A. S. M.

Fif. 4. Continuous, Chain Belt Conveyor Furnaces Made by the Electric Furnace Co., Used for Clean and Bright Hardening Bolts, Screws and Miscellaneous Other Small and Medium Size Finished Products. This furnace design incorporated a cast link alloy conveyor which runs inside the furnace except for a short section which is exposed at the charging end to facilitate loading of parts to be heated. The design of this furnace is similar to a large number of other standard, continuous chain belt conveyor furnaces made by this firm, except that this furnace shell is made gas tight and a special atmosphere is used to prevent oxidation of materials to be heated for quenching.



through alteration of the rate of diffusion of carbon.

Benneck[2] even found differences in decarburization of steels of various carbon contents, heated for 1 hr. at 2280 deg. F. in an oxidizing atmosphere, as the content of Cu or Ni increased from zero to 0.20 per cent.

Difficulties to be Avoided by Use of Controlled Atmospheres

As we well know, at high temperatures solid steel reacts with the oxygen of the air, forming iron oxide scale. The carbon of the steel burns away from the surface, too. Carbon from beneath the surface tends to diffuse to the surface, attempting to equalize the carbon content. Three phenomena thus simultaneously, must be considered, oxidation of iron, decarburization, and diffusion. All three are accelerated by temperature, but their rates are not the same. All three are affected by the carbon content of the steel, and by the presence of alloying elements, so that different steels do not act alike.

Ordinarily speaking, neither scaling nor decarburization is desirable. At sufficiently low temperatures neither may occur to a harmful degree. Thus the

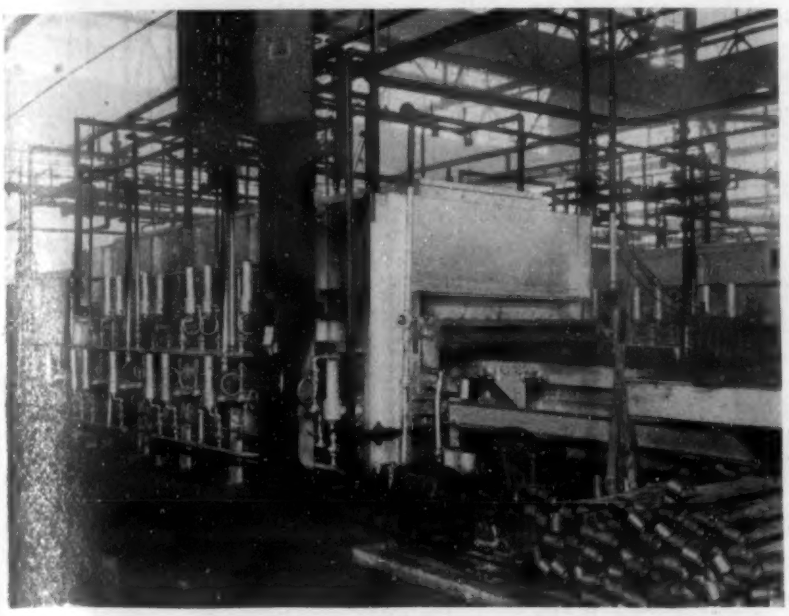


Fig. 5. Continuous Spring Hardening Furnace, with Controlled Atmosphere, at Detroit Steel Products Co. Furnace made by Surface Combustion Co., heated by gas burnt in "radiant tubes," set into the furnace walls, and radiating direct to the work. No muffle is used.

"temper-colored" skin of steel, tempered in air after quenching, is seldom thick enough to cause any trouble, but when tempering temperatures are high, it may be desirable to use a controlled atmosphere in a draw furnace. S. K. Oliver (personal communication) uses an atmosphere resulting from partial combustion of 1 part natural gas with 4 parts air, for tempering up to 1050 deg. F. Tempering in lead or a salt bath is not ordinarily carried out to secure a surface different from that secured in air, but is done for other reasons. Adherent thin coatings such as that on blued steel, the Bower Barff coating, or that on the old planished Russian iron, may be intentionally sought. In some welding operations the presence of scale is considered an advantage.

Effects of Scaling

Higher temperatures, such as are required in heating for quenching, or for rolling and forging, produce heavier scale, especially as the time of heating increases. A heavy forging, heated to a sufficiently high temperature to be workable under the hammer, and

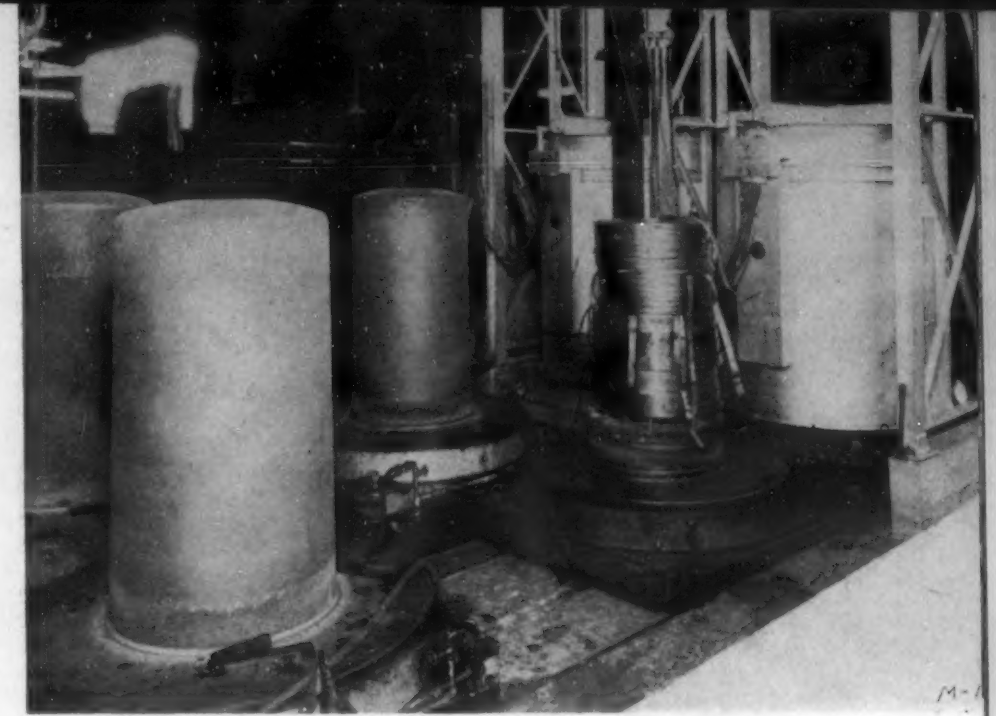


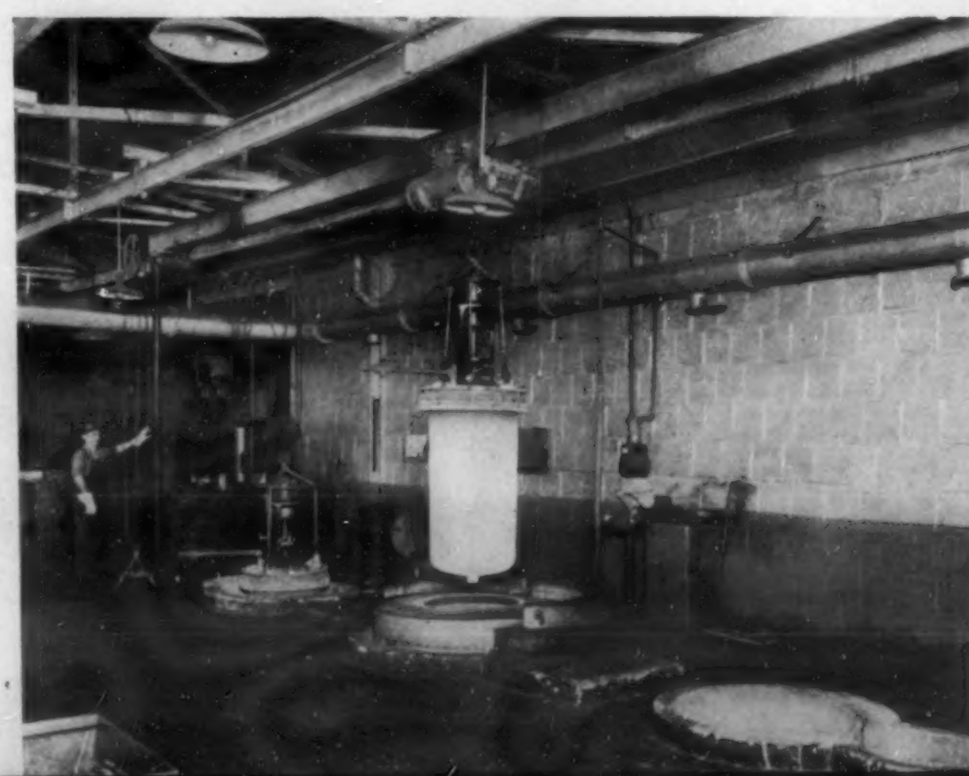
Fig. 6. Bell-Type Furnace for Bright Annealing Coiled Cold-Rolled Strip. Equipment of this type is made by several manufacturers. This is by Westinghouse.

for a sufficiently long time to be properly heated at the center, may lose 5 per cent of its weight. Considerable loss also occurs from ingots in the soaking pits before rolling. Save for the low yield, the scaling may do no harm if the steel is "free scaling" and all scale comes off readily, but if some of the scale adheres and is forged or rolled in, the surface is defective and the scale tends to damage the rolls and dies. (See Figs. 1 and 2).

A similar difficulty occurs in heating for quenching. A heavy adherent scale may insulate the steel and make it refuse to harden satisfactorily on quenching, while one that flakes off in spots and adheres in other spots causes non-uniform hardening. (Figs. 3 and 4).

Even though the scale splits off nicely, the skin may be soft because of decarburization, the oxidation of the carbon occurring faster than that of the iron and diffusion not being rapid enough to keep pace. A soft skin or "bark" is especially bad in tool steels or in wearing parts such as piston pins whose surface is the most important location in the piece. In parts subjected to repeated stress, like a spring, axle shaft, or crank pin, the stresses are maximum at the surface and if there is a softer surface, or one of lower endurance limit than is intended, it may not be able to stand the stress, so the whole part is liable to fail. (Fig. 5).

Fig. 7. An Installation of Hevi-Duty Carburizing Furnaces, Showing the Carburizing Container, with its Oil Feed and Fan, being Lifted from the Heating Furnace. The oil is dripped directly into the container. Installation at National Acme Co.



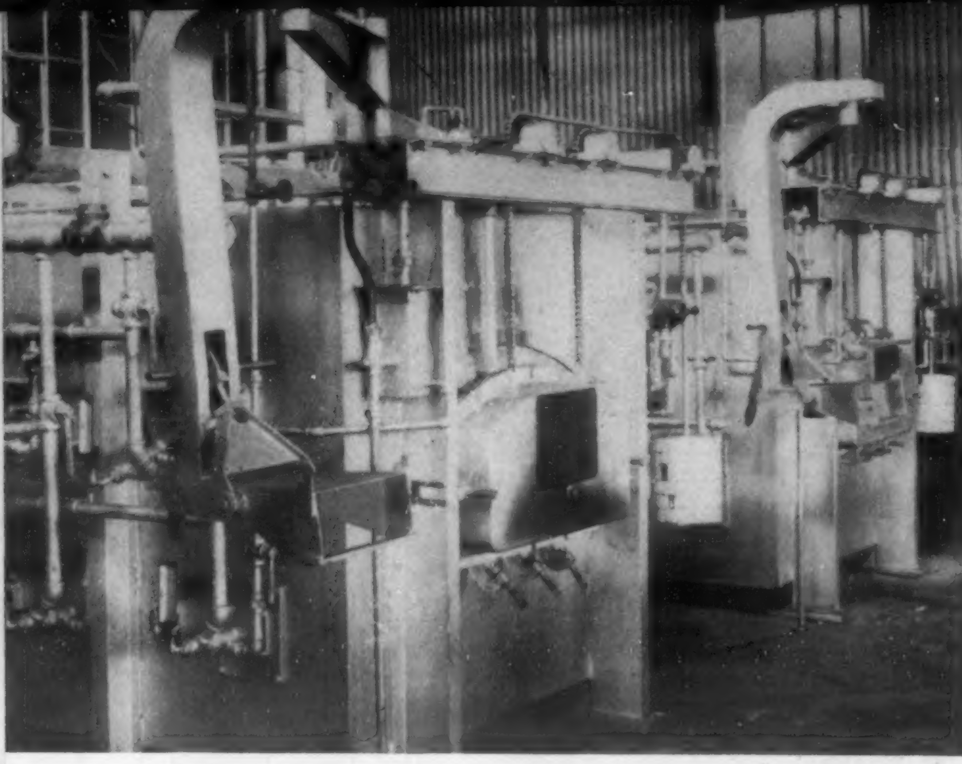


Fig. 7a. Batch Type Gas Carburizing Furnaces, at Electric Auto-Lite Co., Toledo, Built by Surface Combustion Co. These furnaces carburize clutch pinions, bodies and housings. The charge is loaded on alloy pans and these in turn are loaded into the cast alloy muffle 6½ ft. long, 29 in. wide. The muffle is heated by gas burners firing above and below the muffle. It takes 1½ hr. to bring the charge to 1700 deg. F., and it is then held 3 hr., to give an 0.028 in. case on 4620 steel.

The controlled atmosphere led into the muffle is not constant, but is varied according to a regular schedule, in which partly burnt city gas is first led in at a slow rate, then raw natural gas led in at a higher rate, and finally a mixture of the partly burnt city gas and raw natural gas is used to complete the cycle.

Grinding off a soft skin is expensive and the avoidance of this operation is often imperative, particularly in automobile parts.

The annealing of cold rolled sheet and strip, and of cold drawn wire either in process, to allow more cold rolling or drawing, or at the end of the process to give suitable deep drawing and bending properties, is carried out at such temperatures and for such times that scaling would occur in air. When normalizing is used instead of annealing, the times are shorter but the temperatures higher and somewhat similar scaling is encountered. Such scale must be removed by pickling and the pickled surface may have to be given a skin pass to produce suitable smoothness in full finished sheet. Even though pickling normally precedes a final step such as tinning or galvanizing, a non-uniformly scaled sheet that pickles irregularly may not take a good coating. (Fig. 6).

For almost any use, the surface quality of a sheet must meet rigid specifications and inspection, and a decarburized or a carburized surface may especially handicap a sheet to be used for deep drawing. The appearance of a sheet has a definite psychological effect upon the purchaser, who will normally prefer a bright, clean sheet to a dull, stained one, even though the latter might actually serve as well. When lithographed cans are made from untinned sheet, it is necessary that the sheet be clean and unrusted.

Since rust would soon destroy its appearance in service, bare carbon steel sheet has few decorative uses, but in the case of stainless, looks are highly important. "Bright annealing" for steel in general is, however, related to performance rather than to looks, while in the case of copper and brass it is often as much for looks as for properties. The annealing of malleable iron is preferably carried out without surface scaling.

In all these treatments there is ample reason to consider whether we can avoid oxidation of iron to form scale, and removal of carbon to produce decarburization. Since the composition of the steel and the times and temperatures of heating are fixed, the logical way to avoid the troubles is to replace air by some other atmosphere whose composition is so controlled that no harmful reaction occurs between it and the steel.

The first question in selecting the atmosphere is, what are we going to do with the steel after it comes from that atmosphere? The relative importance of mere avoidance of waste of metal by scaling, of securing a type of scale that will be amenable to later pickling, of preservation of dimensions, of avoidance of soft skin, of ability to take a coating, etc., etc., will govern the choice of the atmosphere.

The situation is fairly clear-cut only in the case of gas carburizing. There we at least know that we must use carbon-containing gases and operate without any possibility of oxidizing or decarburizing. Even there the choice of a gas is affected by the depth and type of case sought so that it will not serve just to pick any carburizing gas. (Figs. 7 and 7a).

Temperature Ranges Involved

CHEMICAL reactions go on so much faster as the temperature goes up that a major difference among the various processes calling for controlled

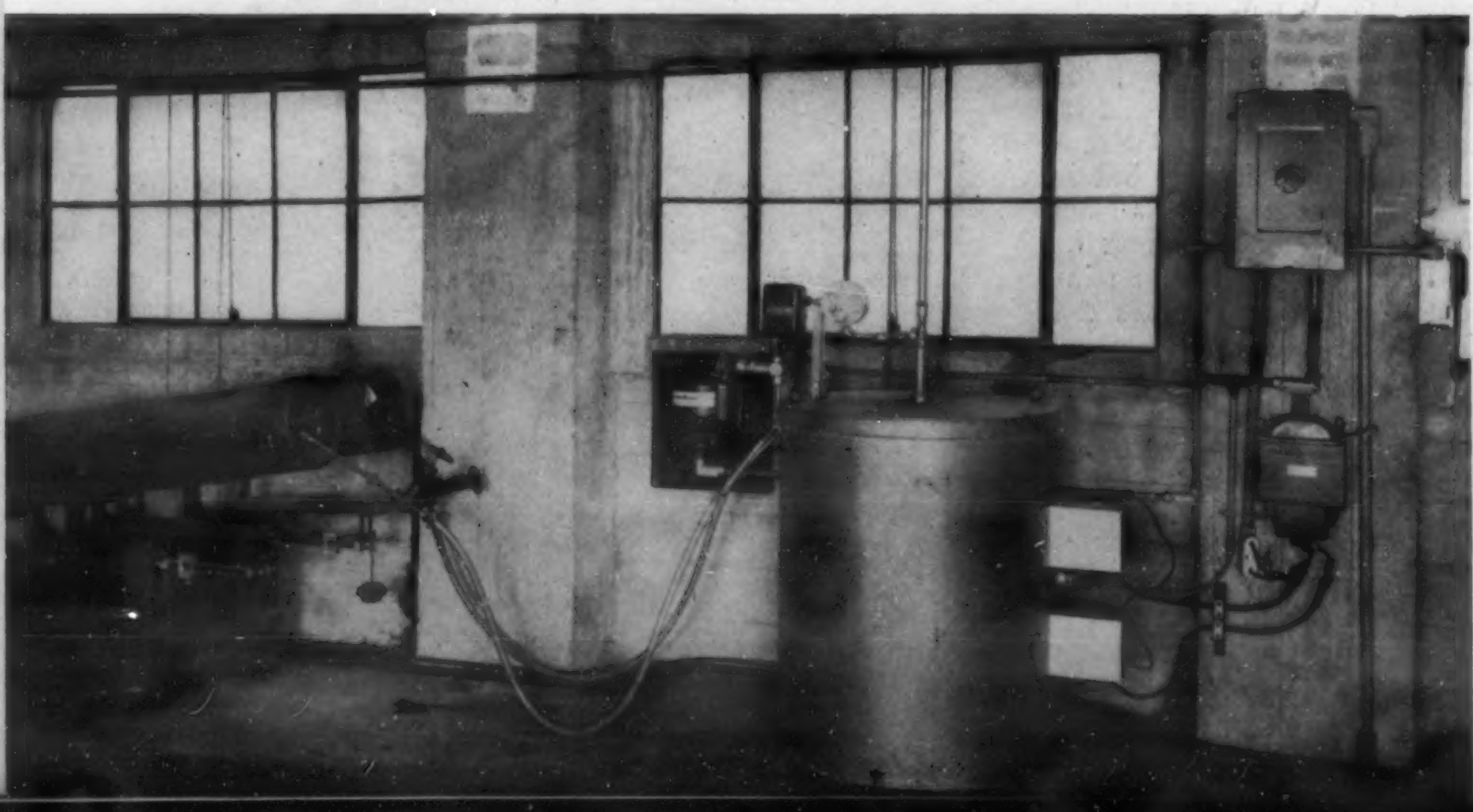
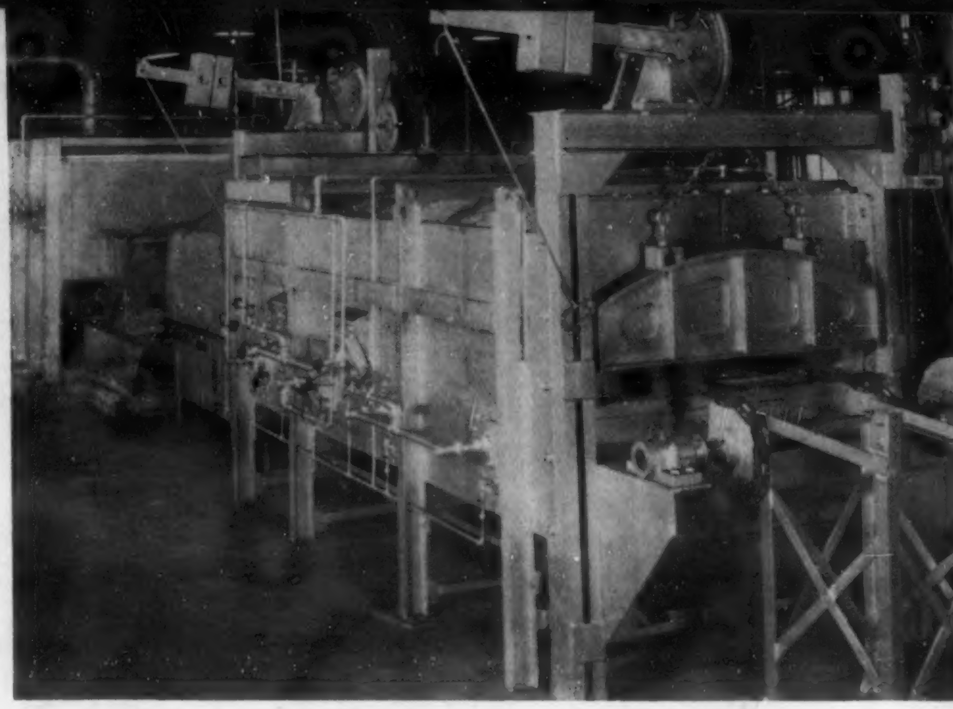


Fig. 8. An Ammonia Dissociator Providing an Atmosphere of $H_2 + N_2$. General Electric make.

Fig. 9a. A Controlled Atmosphere Furnace of the Surface Combustion Co. Installed at Packard for Clean Hardening and Drawing. Capacity is 248 lb. of steel per hr. or 20 shafts from cold to 1600 deg. F. Internal width is 3 ft. 9 in., length 4 ft. Inside this area is an alloy muffle through which the steel passes while being heated. The atmosphere is that prepared in one of the Surface Combustion DX gas preparation machines.

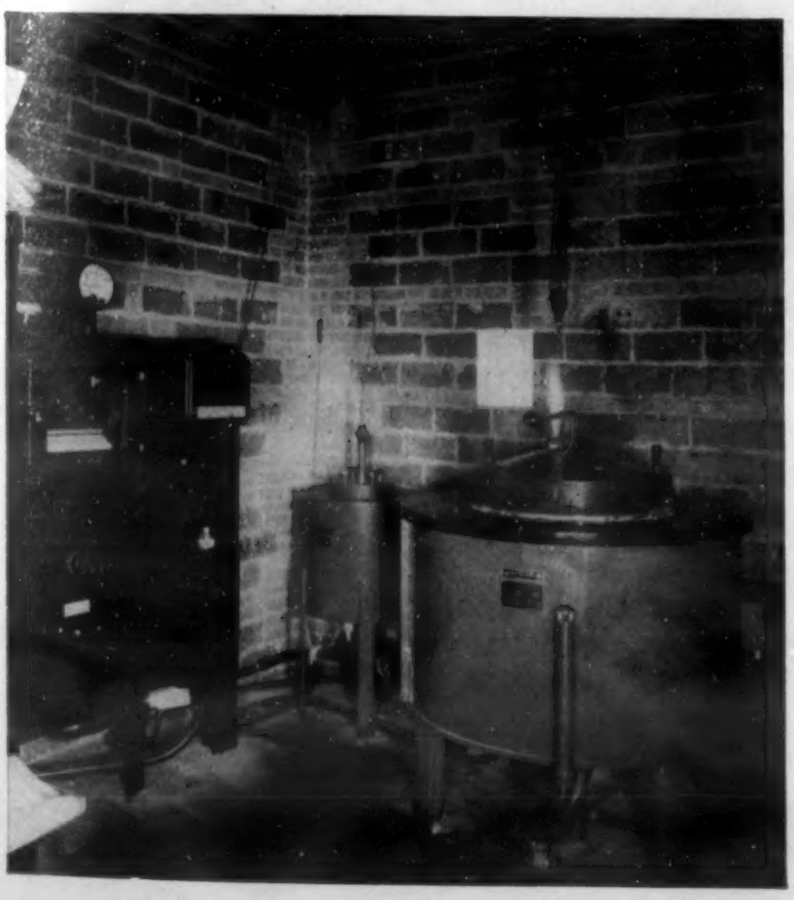


atmospheres is the temperature required. The temperatures will run somewhat as follows, depending, of course, on the carbon content of the steel used:

Heating for rolling or forging, 1600 to 2400 deg. F., steel austenitic.
Preheating high-speed steel, 1550 to 1700 deg. F., steel austenitic.
Hardening high-speed steel, 2300 to 2350 deg. F., steel austenitic.
Heating for quenching, or normalizing or full annealing, 1400 to 1800 deg. F., steel austenitic.
Carburizing, 1450 to 1725 deg. F., austenitic.
Copper brazing, 2100 deg. F., austenitic.
Annealing malleable iron, 1550 to 1600 deg. F., 1st stage, austenitic; 1400 to 1275 deg. F., 2nd stage, ferritic.
Spheroidizing anneal, 1250 to 1475 deg. F., austenitic or ferritic.
"Bright annealing," low-carbon sheet and strip, 1250 deg. F., ±, ferritic.

In the processes carried out at such temperatures that the steel is austenitic, oxidation, decarburization and carburization go on rapidly, depending on the atmosphere used. The bright annealing of cold rolled material, is not accompanied by such rapid decarburization or carburization, not only because of the lower temperature but also because of the much lower

Fig. 9. A Hardening Furnace, made by Leeds & Northrup, in which oil from the container on the ceiling is cracked in a separate "Vapocarb" Unit (in the corner) and the resultant hydrocarbon-hydrogen gas fed into the furnace. Installation at Cleveland Die & Mfg. Co.



solubility of carbon in ferrite than in austenite and the slower rate of diffusion of carbon at these low temperatures, which makes the surface less reactive.

Gases Available for Use in a Controlled Atmosphere

At first blush one may wonder what all the shouting is about, for it would seem to be simple, if one wants to avoid oxidation and scaling, just to use a "reducing atmosphere," i.e., heat in an open furnace with a "reducing flame." The terms "oxidizing and reducing atmospheres" are common in the vocabulary of the combustion engineer who analyzes products of combustion and considers that, when fuel has been burnt with an excess of oxygen and the fuel gases contain free oxygen, he has an oxidizing flame and, when there is a deficiency of oxygen and the carbon has not been completely burnt to CO_2, the flame is reducing. But the matter is far from being as simple as that, when the gases meet hot metallic iron. CO_2 is strongly oxidizing to iron in a certain temperature range. Water vapor, produced by the combustion of the ordinary hydrogen-containing fuels, coal, oil and the commercial fuel gases, is also oxidizing, and over an even greater range of temperature.

An additional factor in the consideration of furnace atmospheres, especially important when gases of combustion meet the work, but also of some consequence in the production of controlled atmospheres by partial combustion of gases that contain sulphur, is the effect of SO_2. All observers agree, and it is clearly brought out by Murphy[3] that the oxidizing tendency of a given atmosphere is markedly increased by quite small amounts of SO_2.

Maurer and Bishof[4] studied the reaction $Fe + SO_2 \rightleftarrows FeS + O_2$ at the temperatures of molten steel, and Whiteley[5] discusses not only the effect of boundary penetration beneath the scale due to the presence of SO_2, but also the effects of S and O in the steel itself.

In the so-called "reducing atmosphere" of combustion gases obtained by burning fuel with a deficiency of air, there may be present CO_2 and H_2O sufficient to oxidize steel very badly even though they are accompanied by some CO, H_2, or unburned hydrocarbons. Even a "smoky flame" does not necessarily connote a reducing atmosphere. J. A. Stein (personal communication) states that he has found 10 per cent O_2 in a natural gas-fired pair furnace so smoky that one could not see across the furnace.

If we strive to overbalance the oxidizing effect of CO_2 and H_2O by increasing the CO, H_2 and hydrocarbons, another complication comes in. Steel con-

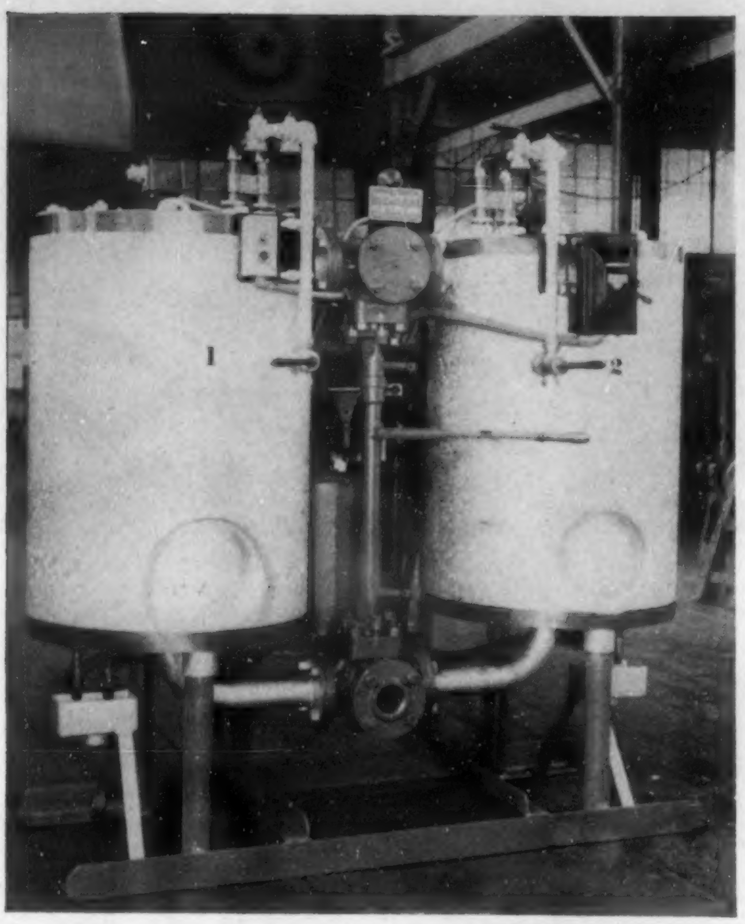


Fig. 10. Activated Alumina Dryer for Controlled Atmospheres made by Pittsburgh Lectrodryer Corp.

tains carbon as well as iron, and CO_2 may not only oxidize iron, but may also oxidize carbon to form CO. But this reaction may be reversed and steel may be carburized by CO, especially in the presence of carbon. The carbon of the steel may also be attacked by hydrogen to form methane, CH_4, and this decarburization may be greatly accelerated by the presence of water vapor.

The inert gases, pure nitrogen, argon, helium, etc., are not used commercially save in very special cases because of the cost of the rare gases and the cost of purification of nitrogen. Nitrogen of course appears as a diluent of other gases in most controlled atmospheres.

Steam, Carbon Dioxide and Hydrogen

Steam, useful in some non-ferrous bright annealing processes, is not applicable for steel, because water vapor is one of the most strongly oxidizing gases to steel. Indeed, even a relatively small amount of water vapor is the most troublesome impurity in most commercial gases for controlled atmospheres.

Carbon dioxide could be readily generated by calcining limestone, but pure CO_2 or N_2-CO_2 mixtures also class as strongly oxidizing.

Hydrogen can be readily obtained by electrolysis, but pure H_2, especially when moist, is strongly decarburizing. Dry H_2, in a mixture of N_2 and H_2 is readily obtainable by cracking anhydrous ammonia. Such an atmosphere has the advantage that it contains only one active gas and one that under no conditions is oxidizing. (Fig. 8).

Atmospheres of Hydrocarbon Gases

Hydrocarbon gases are readily available. Natural gas approaches pure methane, CH_4, in composition, and propane and butane are now readily available. On heating, all these tend to break down ultimately to $C + H_2$, but on account of the relative stability of CH_4 the decomposition can usually be stopped about at the stage represented by $C + CH_4 + H_2$.

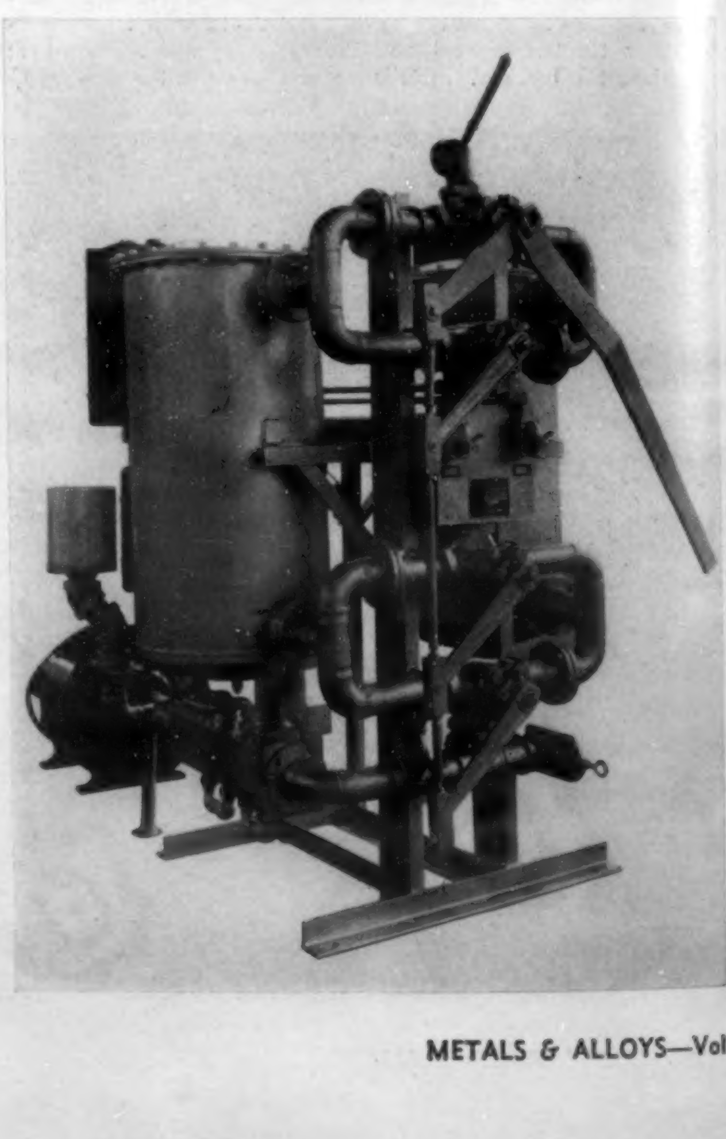
Oil cracks into carbon, hydrogen, and lower hydrocarbons, the gas ultimately becoming high in $CH_4 + H_2$. Thus all the hydrocarbons, introduced directly into a heat-treating furnace, tend to deposit carbon on the work and produce an atmosphere high in hydrogen. City gas varies in composition according to the process by which it is made. In general it contains chiefly CH_4, CO and H_2, with small amounts of ethylene and other impurities. It will normally deposit soot. (Fig. 8 and 9a).

The general tendency, since soot formation is usually not desirable, is not to use the hydrocarbon gases direct, but to utilize them as a source of a balanced composition of CO and CO_2, by partial combustion with air, generally over a suitable catalyst.

The ratio of gas to air is adjusted according to the final composition desired and is usually such that most of the hydrogen is burned to water vapor, most of which is in turn removed in the most advanced practice. This requires the cooling of the gas to throw out the bulk of the water vapor, with the adsorption of the remaining water vapor, usually by silica gel or activated alumina, from which the water is driven off in another operation and the adsorbent regenerated. (Figs. 10 and 11).

Passing the gas through H_2SO_4 or over $CaCl_2$ is also used for drying, but in the larger installations the tendency seems to be to use the silica gel type of adsorbent, since after it has become saturated with water it can be regenerated by heating. However, this introduces more equipment to take care of and another operation to perform. When the more expensive gases, such as those high in hydrogen, sometimes used in the annealing of silicon steel transformer sheet, are employed, the gas may be recirculated through a puri-

Fig. 11. Silica Gel Dryer. This is a front view.



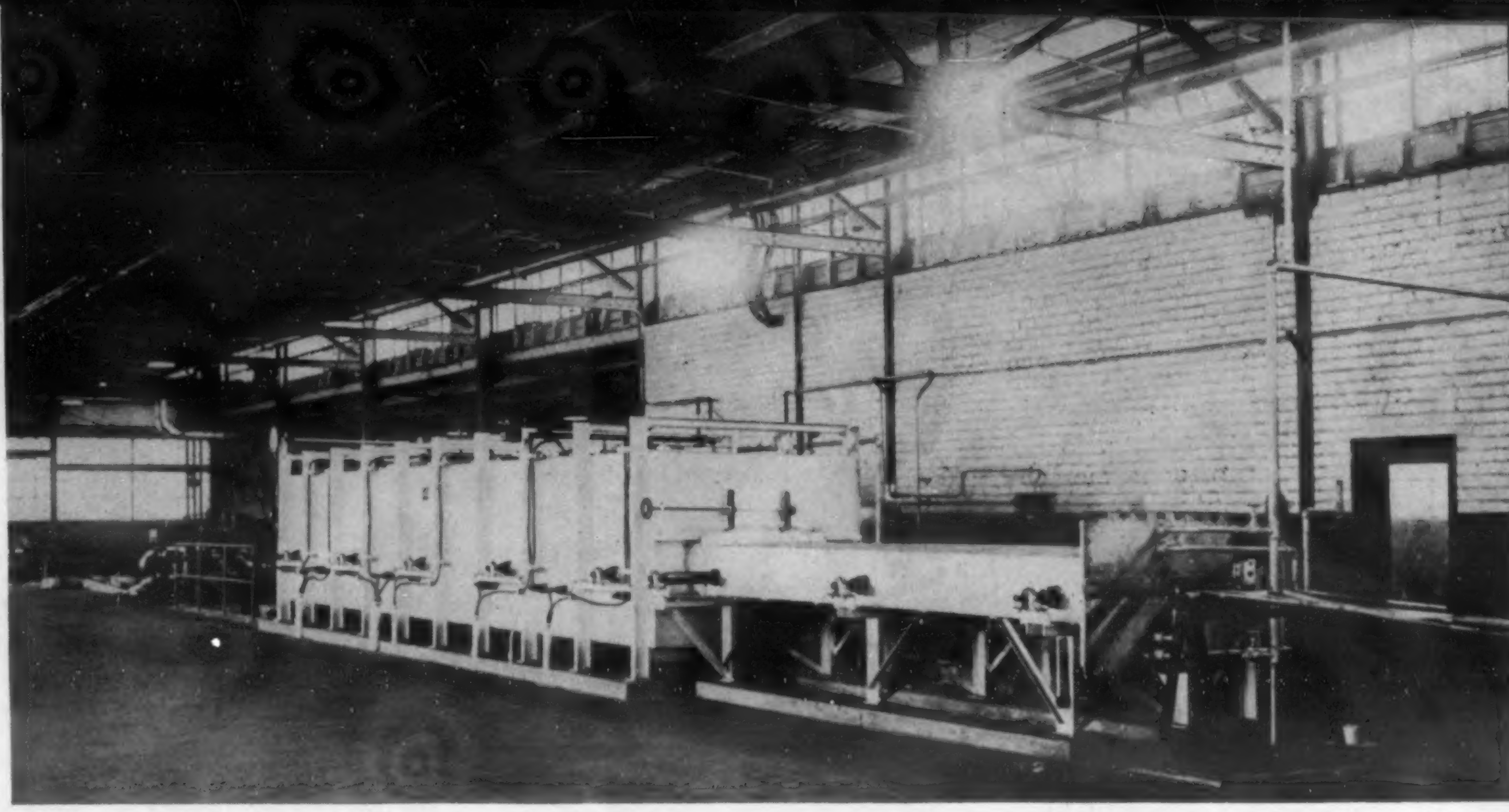


Fig. 12. G. E. Continuous Furnace for Annealing Silicon Steel Strip. Protective H_2—N_2 atmosphere generated in the dissociator shown in Fig. 8.

fying system. The cheaper gases are usually allowed to escape and be wasted after passing through the furnace. (Fig. 12).

Experiments are now being made in absorbing part of the CO_2 from partly burnt gas so as better to control the desired $CO:CO_2$ ratio.

In general considerable H_2 and possibly some unburned CH_4 is left in the gas. Except when the partial combustion takes place irregularly, the gas contains no free O_2 and in use, as soon as the specially formed gas gets into the hot zone, any small amount of O_2 will be consumed by the H_2, CH_4 or CO. Hence the partly burnt hydrocarbons contain CO_2, CO, more or less water vapor, some H_2, and perhaps some CH_4.

Reactions of Gases with Iron and Carbon

THUS the practical controlled atmosphere problem involves a consideration of the effect of N_2, H_2, O_2, CH_4, CO, CO_2, H_2O, singly or in combination, on the iron and the carbon in steel. Obviously the subject becomes highly complicated when we deal with alloy steels, and thus have to consider reactions with other elements.

Some of the possible reactions with Fe and Fe_3C may be listed as follows:

$N_2 + Fe$ — no reaction
$H_2 + Fe$ — no reaction
$O_2 + 2Fe \rightleftarrows 2FeO$* (oxidizing)
$CH_4 + 3Fe \rightleftarrows Fe_3C + H_2$ (carburizing)
$2CO + 3Fe \rightleftarrows Fe_3C + CO_2$ (carburizing)
$CO_2 + Fe \rightleftarrows FeO + CO$ (oxidizing)
$H_2O + Fe \rightleftarrows FeO + H_2$ (oxidizing)
$N_2 + Fe_3C$ — no reaction**
$2H_2 + Fe_3C \rightleftarrows 3Fe + CH_4$ (decarburizing)
$O_2 + 2Fe_3C \rightleftarrows 6Fe + 2CO$ (decarburizing)
$CH_4 + Fe_3C$ — no reaction
$CO + Fe_3C$ — No reaction
$CO_2 + Fe_3C \rightleftarrows 3Fe + 2CO$ (oxidizing)

* FeO can of course be further oxidized to Fe_3O_4 and Fe_2O_3. Actual scale may contain several different oxides.

** Zingg and coworkers (1) mention the possibility of the formation of cyanogen but practical experience does not indicate it.

The gases can react together as follows:

$$\left.\begin{array}{l} 2H_2 + O_2 \rightleftarrows 2H_2O \\ 2CO + O_2 \rightleftarrows 2CO_2 \end{array}\right\} \text{combustion.}$$

$$\left.\begin{array}{c} 2CO \rightleftarrows CO_2 + C \\ CO_2 + H_2 \rightleftarrows CO + H_2O \\ CH_4 \rightleftarrows C + 2H_2 \end{array}\right\} \text{catalysed toward the right by iron surfaces.}$$

Practically all the reactions listed are reversible under the conditions dealt with and the direction depends on the temperature, the proportions of the reactants present, and the specific catalytic effect of the surfaces in contact with the gases, i.e., the steel of the work and the metal or refractory of the hearth enclosure. The rates of those reactions that involve Fe_3C are of course affected by the carbon content of the work; while all the rates will depend on the rate of supply of the gas to the work.

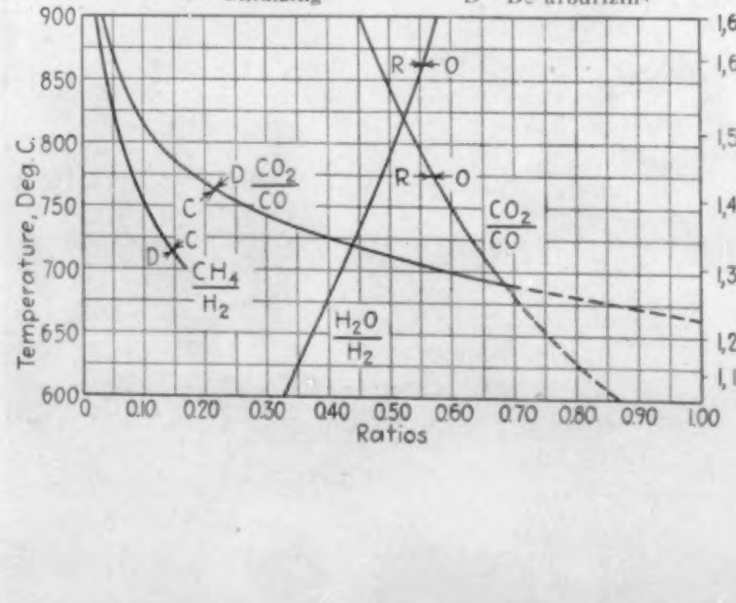
Jominy and Murphy[6], have dealt with the problem of rate of flow. For the reactions of the pairs of gases CO and CO_2; H_2O and H_2; CH_4 and H_2, in contact with austenite saturated with carbon at different temperatures, above A_1, or with ferrite below A_1, the equilibria have been worked out with fair agreement among different workers and are conveniently summarized in Fig. 13 from Stansel[7]. These are for stagnant, equilibrium, conditions and the behavior will be modified if a gas not originally in equilibrium with the steel at a given temperature is passed over the steel, the behavior being affected by the rate of flow.

Pressure, of course, affects the equilibria, and Matsubara[8] discusses its effect, in the course of an extended survey of the reduction of iron oxides and the carburization of iron by CO. The variation in the $CO:CO_2$ equilibrium in contact with C and that in contact with Fe is clearly summarized by Matsubara.

The Curves of Stansel

Stansel's curves are based on equilibrium with austenite saturated with carbon at the temperature in question. In the original publication the curves were carried below A_1 and a field is thus shown, below the point at which the curves for $\frac{CO_2}{CO}$ cross, in which oxidation and carburization are indicated to occur simultaneously. This is unlikely, because carburization of

Fig. 13. Equilibrium Ratios for the CH_4—H_2: CO_2—CO; and H_2O—H_2 Reactions, in Contact with Iron-Carbon Alloys Saturated with Carbon at the Temperature in Question. Stansel[7]



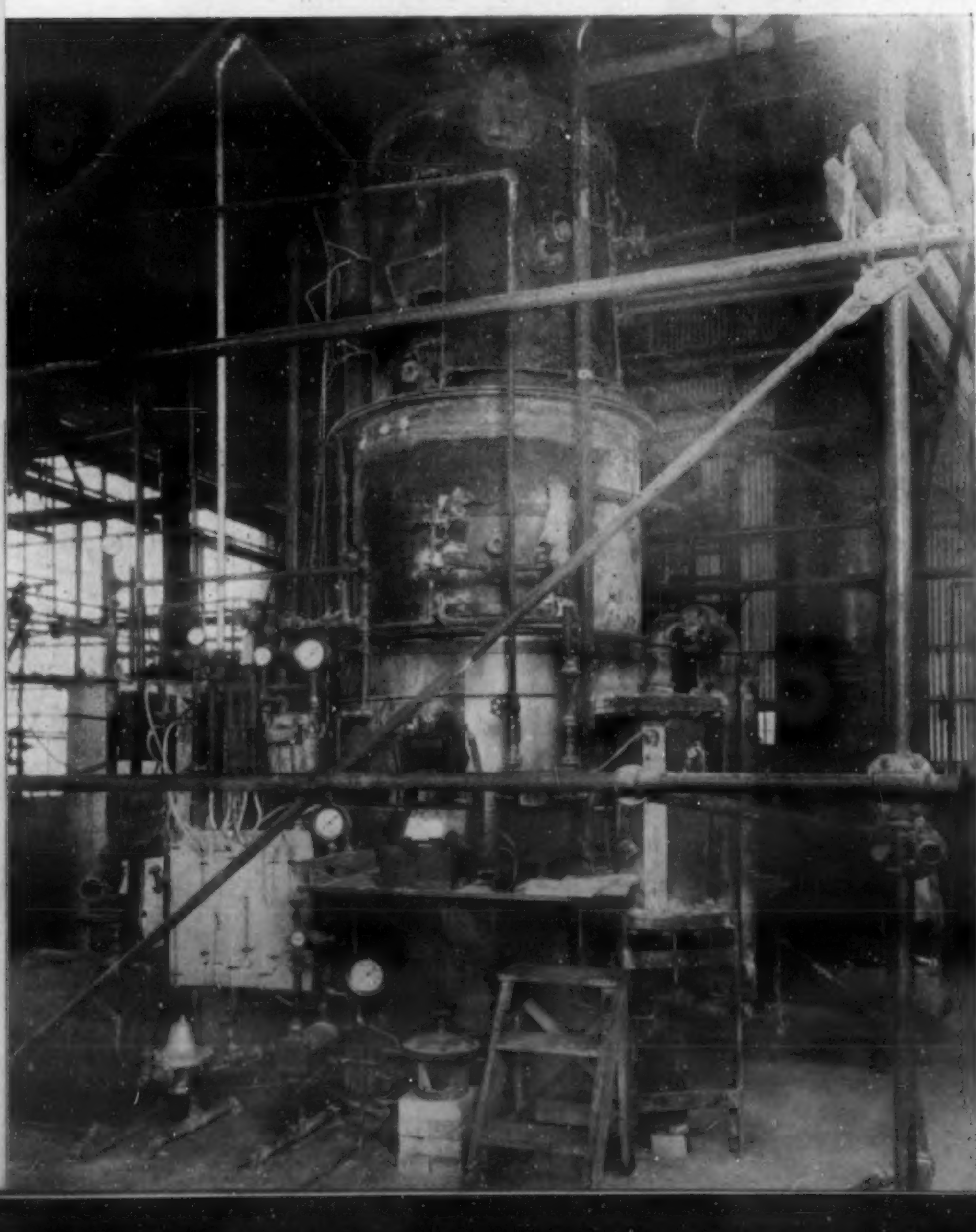
ferrite is very slow if it occurs at all. Hence the curves have been drawn dotted below the crossing point. The carburizing curve should end at A_1, just as Stansel's curve for $\frac{CH_4}{H_2}$ ends there.

However, there is a decarburizing action upon cementite below A_1 by H_2, and possibly by CO_2. H. A. Schwartz (personal communication) states that hydrogen dried and purified by passing over hot copper and through molten Na-K alloy, removes carbon from white iron at temperatures in the range of 400 to 600 deg. F.

It should also be remembered that these curves are for equilibria with the carbon in the steel. There are other similar curves for equilibria with free carbon so that, if soot is present, the gas phase will tend to approach equilibrium with carbon. Iron catalyses the reactions producing equilibrium with carbon. A steel of any other carbon content, other than the one that happens also to be in equilibrium with the gas that is in equilibrium with carbon, will then tend to be either carburized or decarburized and the effect upon the steel will depend on the rates of carburization and decarburization and on the time required for the heat-treatment and thus allowed for action.

If the carburizing and decarburizing rates are sluggish, or if the gas mixture can be maintained in a metastable state, it may be practically possible to operate without noticeable attack upon the steel under conditions which the equilibrium diagrams indicate to be unusable.

Fig. 14. Experimental Equipment of Union Carbide & Carbon Co. for the Production of N_2 — H_2 Gas. Butane is vaporized in a steam-heated vaporizer at the right of the blower, in the foreground, and mixed with air from the blower, the mixture being regulated by the pressure gases. The mixture is burnt in the lower part of the cylinder in the center of the picture. Steam, superheated in the upper section of the cylinder, and the combustion products are then led over the first stage catalyst. See Fig. 6.



The curves show that in a water vapor atmosphere whose oxidizing tendency is balanced by H_2 (say at 1500 deg. F. with a $\frac{H_2O}{H_2}$ ratio of 0.50), cooling below that temperature will result in oxidation. Hence, the proportion of water vapor must be strictly limited when steel is to be cooled in the furnace. With CO and CO_2, however, any ratio that is not oxidizing at a high temperature, will continue to be not oxidizing at any lower temperature though it may be decarburizing or carburizing. The chart makes it clear that water vapor, or CO_2, unbalanced by a reducing gas, will be oxidizing at any heat-treating temperature.

As far as mere scaling goes, the effect of the H_2, H_2O, CO and CO_2 mixtures can be deduced from the $CO:CO_2$ ratio alone, since the total equilibrium is expressed by the ratio $\frac{(H_2O)\ (CO)}{(H_2)\ (CO_2)}$ of the water-gas constant, so if a non-scaling $CO:CO_2$ ratio is chosen, the $H_2O:H_2$ ratio in eqilibrium with it will also be non-scaling. But this does not hold for decarburization.

Curves for the dissociation of $2H_2O$ vapor to $2H_2+O_2$ and $2CO_2$ to $2CO+O_2$, as well as the equilibrium constant for the water gas reaction are shown by DeBaufre[9].

Effect of Carbon Content of Steel on the Gas Equilibria

BECKER[10] has evaluated the $CO:CO_2$ ratio for equilibrium, under static conditions, of the gas mixture with steels of varying carbon content, and reports that the admissible percentage of CO_2 (the balance being CO) runs as follows at different temperatures:

Temperature Deg. C.	Deg. F.	1.5% C steel	0.1% C steel
650	1200	56	56
700	1290	38	38
750	1380	22	28½
800	1470	10	25
850	1560	4½	27
900	1650	2	19½
950	1740	1	10½

Intermediate carbons are in equilibrium with intermediate percentages of CO_2, as shown by a series of curves in Becker's article.

Austin[11] quotes Fourquignon that, at 1830 deg. F., a steel saturated with carbon is in equilibrium with a gas containing 99 per cent H_2, 1 per cent CH_4 while a steel of 0.15 per cent C is in equilibrium with one of 99.9 per cent H_2, 0.1 per cent CH_4.

Thus it is obvious that the curves of Fig. 13 will be shifted in position with each change in carbon content of the steel and that, if we seek to utilize gas mixtures that are in equilibrium with the steel, the gas mxture must be varied whenever the furnace is used for a different steel from the one the atmosphere is adjusted for.

Effect of Alloy Content

NATURALLY there will be another shift for each change in alloy content, when we go from carbon to alloy steels. Thus Ni-Cr-Mo steels are more prone to decarburize than a plain carbon steel, and the new Mo and MoW high-speed steels than the ordinary W high-speed steel.

In an extensive investigation of spring steels at the National Physical Laboratory and Sheffield Uni-

versity (important articles on which are by Hankins and Becker[12], Hankins and Mills[13] and Andrew and Richardson[14]) the evil effects of decarburization upon the performance of springs has been clearly brought out, and it is becoming apparent that the reliable behavior of Cr-V spring steels in comparison with those of Si-Mn steel may be in considerable part ascribable to lesser decarburization of the Cr-V steel when heat-treated in air or in contact with products of combustion. Conversely, if decarburization of Si-Mn can be avoided by controlling the atmosphere, better and more uniform properties would result. In view of the present interest in Mo spring steels and the known tendency of Mo steel to decarburize, the controlled atmosphere problem is a very live one in relation to spring steels.

Hankins decarburized some of his specimens by using $CO:CO_2$ mixtures of the decarburizing area shown in Fig. 13 so as to avoid oxidation and get decarburization only. Austin[15] produced similar results to those of Hankins by decarburizing with moist H_2.

The effect of alloying with Cr, in decreasing the propensity to scale is well known, and this, as well as the effect of some other elements is discussed by Heindlhofer and Larsen[16].

We cannot here do more than merely mention the effect of alloying in order to emphasize how much it complicates the controlled atmosphere problem and how it militates against the selection of some one "universal" atmosphere usable for all steels irrespective of carbon, alloy, or temperature of heating.

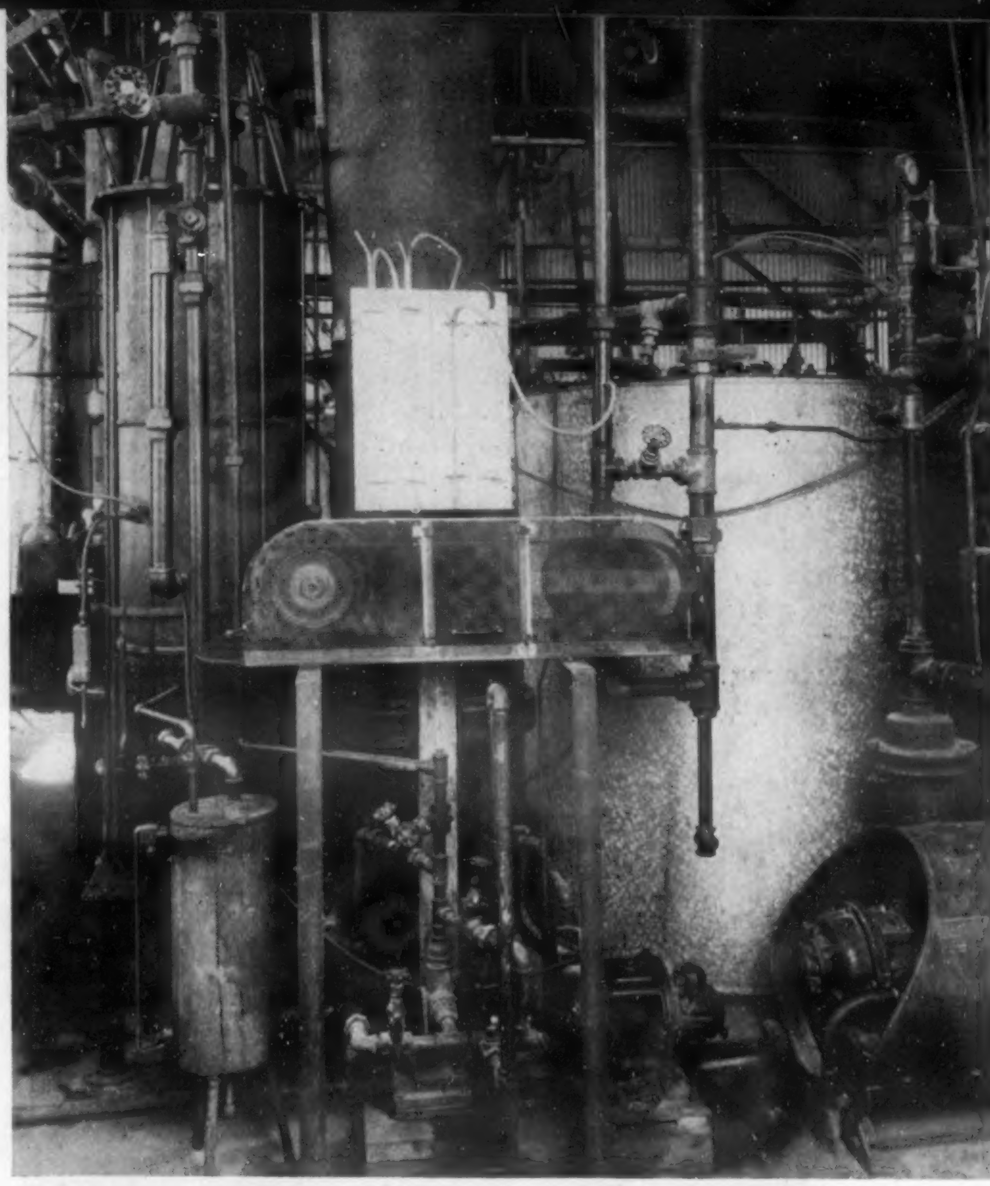


Fig. 15. The First Stage Catalyst is Inside the Galvanized Tank at the Right. The emerging gas is cooled in the central cylinder and passed to the CO_2 absorber at the left. When CO is to be brought down under 0.5 per cent, the gas passes to the equipment shown in Fig. 16.

Gases Eliminated from Consideration

STEAM.—It has already been noted that pure water vapor is oxidizing to steel at heat-treating temperatures, even though it is a satisfactory atmosphere for bright annealing some copper alloys. Jominy[17] cites an interesting case of an electric furnace, hardening gears, which produced decarburized surfaces from time to time. The trouble was traced to a nearby tank from which steam would blow into the furnace when the wind was in that direction. Thus the oxidation due to steam is likely to be accompanied by decarburization.

Meyer and Skroch[18], in a brief note, discuss decarburization under the scale on 0.40 per cent C steel heated to 2400 deg. F. for rolling, in two furnaces, one fired with mixed blast furnace and coke oven gas, the other with pea coal. The flue gas from the former had 0.3 per cent free O_2, and 140 g. per cu. m. water vapor while that from the latter had 1.7 per cent O_2, 50 g. per cu. m. water vapor. Decarburization was worse in the gas furnace in spite of the lower oxygen and it is suggested that the variation in decarburization may be due to the water vapor. The heating time was considerably longer in the gas furnace, so that the comparison is not exact.

Carbon Dioxide.—This gas by itself is oxidizing, according to the reaction $CO_2 + Fe = FeO + CO$, so that in contact with iron it will break down and oxidize the steel until enough CO has been produced to bring the gas mixture into equilibrium.

The use of pure steam, pure CO_2 or of N_2-H_2O or N_2-CO_2 mixtures, without some other gas to neutralize their oxidizing effect, is thus eliminated from consideration for our present purposes.

Bibliography

1 E. von Zingg, P. Oberhoffer and E. Piwowarsky. "Der Einfluss des Herstellungverfahrens und der Glühatmosphäre auf das Randgefüge der Werkzengstähle." *Stahl und Eisen*, Vol. 49, 1929, pages 721-725, 762-768.

2 H. Bennek. "Einfluss Kleinster Beimengungen von Kupfer und Nickel auf Kohlenstoffstähle." *Technische Mitteilungen Krupp*, Vol. 2, Dec. 1934, pages 129-133.

3 D. W. Murphy. "Behavior of Steel in Sulphur-Containing Atmospheres at Forging Temperatures." *Transactions*, American Society for Steel Treating, Vol. 21, 1933, pages 510-531.

4 E. Maurer and W. Bishof. "The Behavior of Sulphur in Open-hearth Furnace Gases." *Journal*, Iron and Steel Institute, Vol. 129, 1934, Pt. 1, pages 123-143.

5 J. H. Whiteley. "An Effect of Oxygen and Sulphur on Iron in Scaling." *Journal*, Iron and Steel Institute, Advance copy No. 10, May, 1935, meeting, 19 pages. *Heat Treating and Forging*, Vol. 21, May, 1935, pages 223-228.

6 W. E. Jominy and D. W. Murphy. "Scaling of Steel at Forging Temperatures. *Transactions*, American Society for Steel Treating, Vol. 18, 1930, pages 19-50.

7 N. R. Stansel. "Industrial Electric Heating." J. Wiley & Sons, New York, 1933, 444 pages.

8 A. Matsubara. "Chemical Equilibrium Between Iron, Carbon and Oxygen." *Transactions*, American Institute of Mining Engineers, Vol. 67, 1922, pages 3-54.

9 W. L. De Baufre. "Dissociation of Products of Combustion." *Combustion*, Vol. 6, May, 1935, pages 23-31.

10 M. L. Becker. "Carburizing and Graphitizing Reactions Between Iron-Carbon Alloys and CO and CO_2." *Journal*, Iron and Steel Institute. Vol. 121, 1930, Pt. 1, pages 337-361.

11 C. R. Austin. "A Study of the Effect of Water Vapor on the Surface Decarburization of Steel by Hydrogen, With Certain Developments in Gas Purification." *Transactions*, American Society for Metals, Vol. 22, Jan. 1934, pages 31-58.

12 G. A. Hankins and M. L. Becker. "The Effect of Surface Conditions Produced by Heat Treatment on the Fatigue Resistance of Spring Steels." *Journal*, Iron and Steel Institute, Vol. 124, 1931, Pt. 2, pages 387-428.

13 G. A. Hankins and H. R. Mills. "The Resistance of Spring Steels to Repeated Impact Stresses." Iron and Steel Institute, Advance copy, No. 4, May, 1935 meeting, 11 pages.

14 J. H. Andrew and G. T. Richardson. "An Investigation of Spring Steels." Iron and Steel Institute, Advance copy, No. 2, May 1935 meeting, 21 pages.

15 C. R. Austin. "Effect of Surface Decarburization on Fatigue Properties of Steel." METALS & ALLOYS, Vol. 2, September, 1931, pages 117-119.

16 K. Heindlhofer and B. M. Larsen. "Why Do Some Metals Resist Oxidation?" *Metal Progress*, Vol. 26, No. 3, 1934, pages 34-37.

K. Heindlhofer and B. M. Larsen. "Rates of Scale Formation on Iron and a Few of Its Alloys." *Transactions*, American Society for Steel Treating, Vol. 21, 1933, pages 865-895.

17 W. E. Jominy. "The Surface Decarburization of Steel at Heat Treating Temperatures." Dept. of Engineering Research, University of Michigan *Bulletin 18*, 1931, 49 pages.

18 J. Meyer and K. Skroch. "Untersuchungen au Walzwerksöfen über Abbrand und Randentkohlung. *Stahl und Eisen*, Vol. 55, Apr. 11, 1935, page 423.

Part II—Cost and Action of Different Usable Gases

Nitrogen

IT would seem that the most logical atmosphere would be the inert one, pure nitrogen. But such an atmosphere has no factor of safety in that there is no reducing gas present to combine with traces of infiltered air. In bright annealing, even a tiny trace of oxygen in the nitrogen will stain the steel. There is no simple means on the market for purifying air from oxygen and producing pure nitrogen on the spot where it is to be used.

Cylinder N_2 is available, but it is usually contaminated with a trace of oxygen and its complete purification is difficult as Schultz and Hülzbruch[19] and Jominy[17], de Coriolis and Cowtn[20] and several others show. But an even greater drawback is its cost—$11.00 per M.

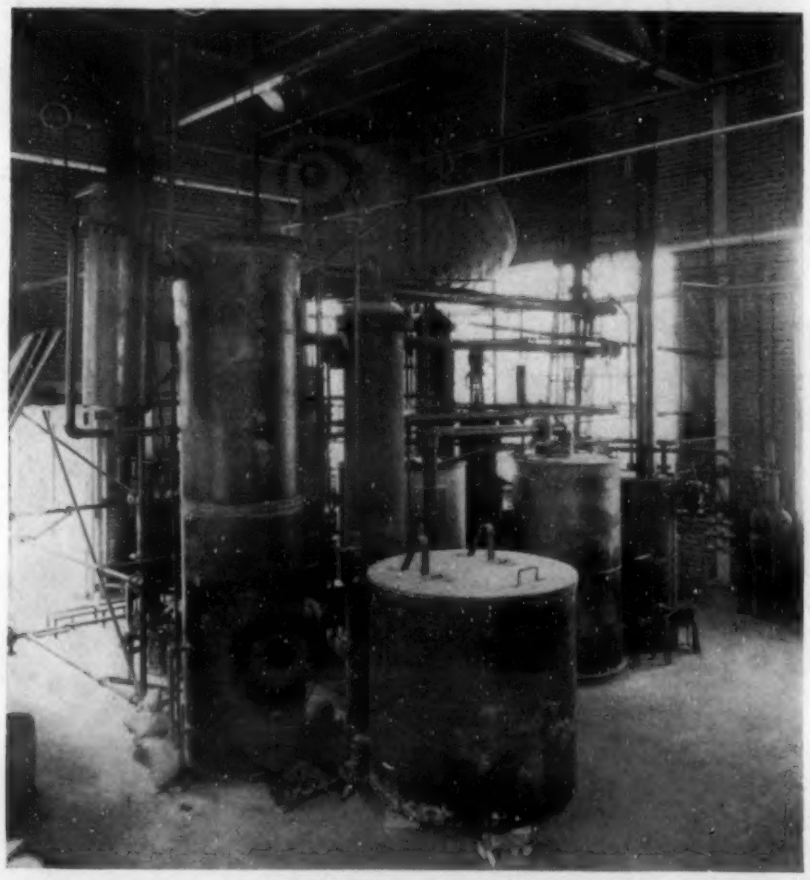


Fig. 16. Going from right to left in this Photograph is a Heater for the Gas and Secondary Steam, the Second Catalyst Chamber, a Gas Cooler, and a NaOH Tower for Final Removal of CO_2. Fresh NaOH is stored in the tank in front. After removal of CO_2 by NaOH, the gas then goes to a dehydrating unit.

Hydrogen

Cylinder H_2 is also available and also costly—$10.00 per M. Hydrogen could be made on the spot by electrolysis, but would, for most uses, require drying. If decarburization is not objectionable and scaling only is to be avoided, wet hydrogen may be used. The behavior of wet hydrogen is of importance because, if one seeks to produce a neutral atmosphere by the partial combustion of city gas, natural gas, propane, butane, etc., the partly burnt products contain both hydrogen and water vapor from the decomposition of the hydrocarbons. If we consider first the H_2, H_2O mixture alone, we see from Fig. 13, (METAL & ALLOYS August, page 201) that while sufficient H_2 will overcome the oxidizing effect of water vapor at a given temperature, at a lower temperature it takes more hydrogen to keep the mixture reducing. Hence if we try to get a neutral gas by hydrogen and steam at a given temperature, that is, to come so close to the line in Fig. 13, dividing the oxidizing field from the reducing field that the rate of reaction will be low, when the steel cools to a lower temperature in this atmosphere, it will oxidize.

A. B. Kinzel (personal communication) states that H_2 purified to a moisture content of under 0.1 grain per cu. ft. will oxidize steel at temperatures below 900 deg. F., while at 1050 deg. F. comparatively large amounts of water vapor may be present. He also remarks that if steel is cooled in H_2 of 0.1 grain per cu. ft. moisture with the H_2 pressure maintained, but no flow of hydrogen, the steel will remain bright instead of oxidizing.

Pure H_2 is used in some special cases. Austin[27] discusses its use for annealing of silicon transformer steel.

While Austin[21] once alleged that dry hydrogen was as decarburizing at 850 deg. C. as moist hydrogen, the findings of Campbell[21a] Schultz and Hülzbruch[19] and of Jominy[17] clearly shows that Austin's early statement is not correct as a broad generalization, and in a later paper [11] he reports that while pure H_2 has a real but limited decarburizing power, water vapor materially serves to hasten carbon elimination.

Eilender [22] reports that, in work apparently available only in Clasen's thesis, Houdremont and Clasen studied decarburization by moist H_2 of carbon steels made in different ways and found quite a difference in their behavior, a very pure steel made in a high-frequency furnace on a basic lining showing the most rapid decarburization.

There is no need for a pure H_2 atmosphere, for nitrogen would never harm a controlled atmosphere containing sufficient hydrogen. Hence instead of pure hydrogen, hydrogen diluted with nitrogen would ordinarily be used.

A theoretically interesting way of producing a hydrogen atmosphere free from water vapor suggests itself from the work of Alexander[23] who used calcium hydride to produce hydrogen for the reduction of chromic oxide. Above about 1800 deg. F. calcium hydride decomposes, 1 c.c. of the compound producing 3100 c.c. of hydrogen, and freeing metallic calcium. If any water vapor is present this will react with the calcium to form lime and more hydrogen, so that the net result is the production of dry H_2.

Were it not for the cost of calcium hydride, one could either feed calcium hydride direct into the muffle, or generate the H_2 by heating the calcium hydride in a separate retort and feed the gas in.

Mixtures of H_2-N_2

These could be made from electrolytic hydrogen, burnt with a deficiency of air, and the resulting water vapor removed by dropping out some by cooling, and absorption of the remainder by H_2SO_4, silica gel, or activated alumina.

A more convenient method, and one industrially employed, is to crack anhydrous liquid ammonia by application of heat, producing moisture-free gas of 75% H_2, 25% N_2. Berliner[24], and La Pelle and Carpenter[25] have described its use. Such a gas costs approximately $3.50 per M. There are explosion hazards in the use of a gas so high in H_2.

It is, of course, not necessary to go through the NH_3 stage, for a gas mixture such as is used to make the NH_3 from in the first place could be used. Eisenhut[26] suggests treatment of CH_4 with air and steam in an electric arc to produce first a gas of 42 per cent H_2, 25 per cent N_2, 32 per cent CO and then treating that gas with steam over Ni to oxidize the CO to CO_2 and at the same time produce more H_2, then chemically removing the CO_2 so as finally to give 25 per cent N_2, 75 per cent H_2.

Austin[27] has discussed the annealing for 2 hr. at 1430 deg. F. of high-carbon drill rod in cracked ammonia, dried, with activated alumina, down to 1 milligram of water per cu. ft. If the drill rod had a film of oxide on it originally so that water vapor was formed from it during the anneal, decarburization occurred, while if the oxide had been removed by pickling, there was no decarburization.

More Dilute N_2-H_2 Mixtures

The cracked gas from liquid ammonia can be burnt with a deficiency of air and the water removed. Robiette [28] has discussed the preparation of such gases with from 90 per cent N_2-10 per cent H_2 to 99 per cent N_2-1 per cent H_2. Such a gas, he says, will cost approximately $2.25 per M.

Kinzel, in discussion of a paper by Austin[27] advocates such gas for bright annealing. He also states (private communication) that tool steel has been annealed in 93 per cent N_2, 7 per cent H_2 without a trace of oxidation or decarburization, the annealing having been carried out above the transformation temperature.

Such gas mixtures are obtained bv partial combustion of natural gas, propane or butane with a deficiency of air, and passing the resulting gas plus steam over a catalyst to oxidize the CO of the original combustion products to CO_2 and release hydrogen from the steam. At this stage the gas has the desired N_2:H_2 ratio, which has been achieved by proper proportioning of the gases at each stage, is free from hydrocarbons, is low in CO but high in CO_2, and contains water vapor.

The cooled gas is then freed from CO_2 by absorption of CO_2 in an aqueous solution of some organic compound that will take up large amounts of CO_2 at ordinary temperatures but from which the CO_2 can be boiled off so that the solution can be regenerated.

If CO is to be brought below 0.5 per cent, another treatment with steam over the catalyst may be applied. The last of the CO_2 is then removed by treatment with NaOH. This leaves only the water vapor to be eliminated which is done by chilling or by passage over activated alumina. It is calculated that a 90 per cent N_2-10 per cent H_2 gas for bright annealing can thus be produced for about 20 cents per M.

Experimental equipment for producing such a gas mixture is shown in Figs. 14, 15 and 16. Commercial equipment is much more compact, but the apparatus pictured shows the separate steps in the chemical process more clearly than does the photograph of the commercial equipment, Fig. 17 or 18.

Mixtures of H_2-CO (Copper Brazing)

By treatment of city gas with steam at about 2000 deg. F. it is possible to produce a gas (the so-called "electrolene") high in hydrogen (67%) and in CO (25%) at a cost of about $1.00 per M. When two steel pieces are closely fitted together, some copper placed at the joint, and the whole heated in a strongly reducing, high-hydrogen atmosphere, to about 2100 deg. F., the copper melts and runs by capillarity into the joint. When the joint is cooled, the copper brazes it tightly. Molybdenum resistors can be used in such atmospheres but must never be allowed to come in contact with oxygen when hot. Webber[16] has described the outfit. (See Fig. 19).

Various high-hydrogen atmospheres have been used for copper brazing. Some difficulty has been met owing to the decarburizing action of hydrogen, since it is often desired to braze wearing parts which cannot stand having a soft skin.

Efforts to use cheaper gases have been made, as

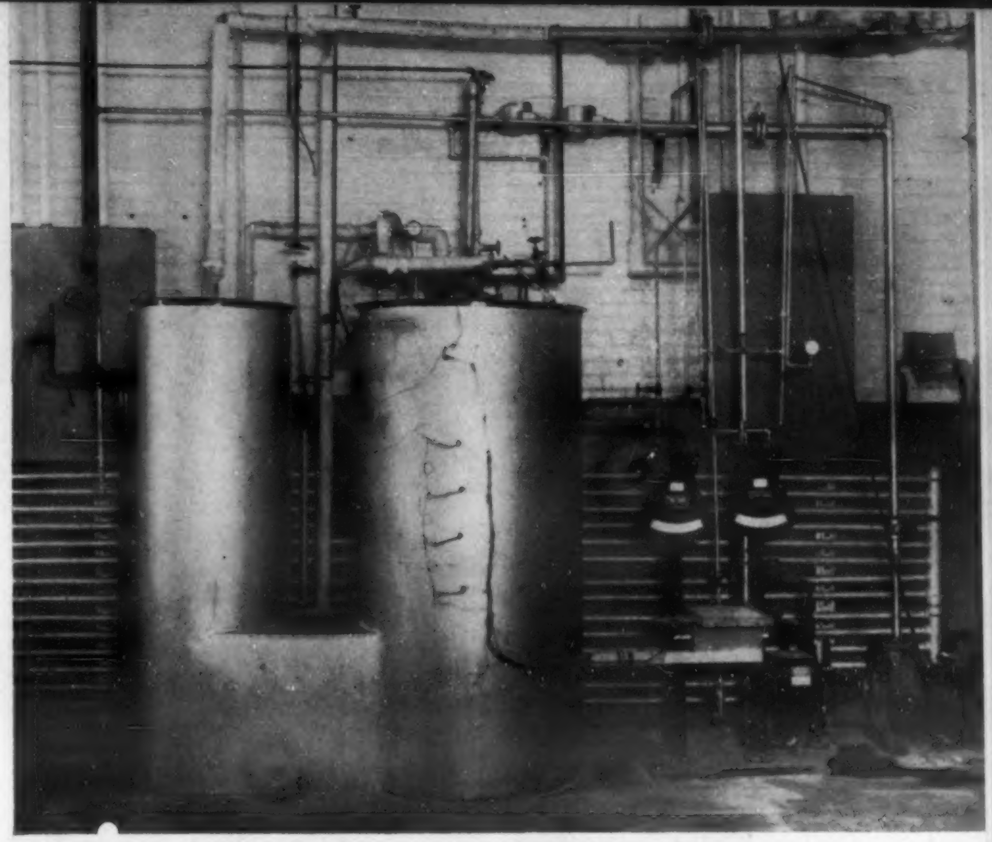
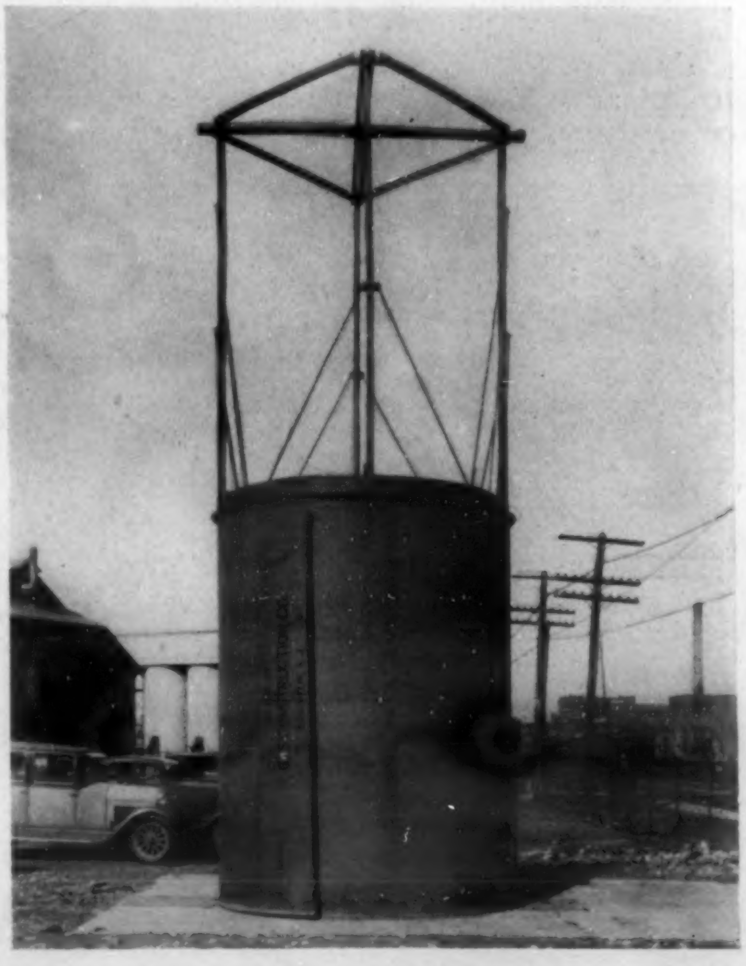


Fig. 17. Commercial Equipment of Union Carbide & Carbon Co.—a more Compact Form of the Experimental Apparatus shown in Figs. 14 to 16. The gas is dried in an activated alumina dryer similar to that shown in Fig. 10.

Fig. 18. Gasometer for Storage of N_2 — H_2 Gas Mixture Prepared in the Equipment Shown in Fig. 17.



described by West[30], who states that the cost can be brought down to 20 or 30 cents per M. One user of copper brazing makes a cheap gas, containing about 12 to 20 per cent H_2, 10 to 15 per cent CO, 4 to 5 per cent CO_2 by partial combustion of natural gas. The gas is sufficiently reducing to permit free flow of the copper and tight brazing. The steel, because of the proportion of CO_2 in the gas, has an adherent blue oxide coating, which may be removed by pickling. Little decarburization will be encountered under such a scale. When decarburization is not important, the work can be brought out bright by regulating the proportion of air in the preforming of the gas and thus working with a lower CO_2 content.

Boegehold[31] mentions the use of CO in the bonding of copper-lead bearing alloys to steel backs, which might be considered analogous to copper brazing. He states that he avoids H_2 for the purpose because of its tendency to make the Cu-Pb lining gassy, but does not give details as to the necessary purity of the CO or what proportion of N_2 it may contain.

Fuel Gases

City gas of course varies in composition with its method of manufacture but is usually about half hydrogen, a quarter methane with a smaller amount of CO and still smaller amounts of nitrogen, ethylene, CO_2 and O_2. It is widely available at a cost usually not far from $1.00 per M. It will deposit carbon on heating in absence of air.

Producer gas, made from soft coal by treatment with air and steam, has CO as its main constituent. Hydrogen is the next chief constituent, and CO_2 the next. It might contain, after drying, 20 per cent CO, 10 per cent H_2, 7 per cent CO_2 and 3 per cent CH_4. Small producers to supply on the spot the relatively small amount of gas required for controlled atmospheres are not on the market, but a plant making producer gas for other purposes could consider clean producer gas a material for further treatment, which would include purification from the SO_2 from the sulphur of the coal and probably from some of its CO_2, since the CO_2 content is rather high for most controlled atmospheres. The cost of the gas would, before purification, be of the order of 10 cents per M

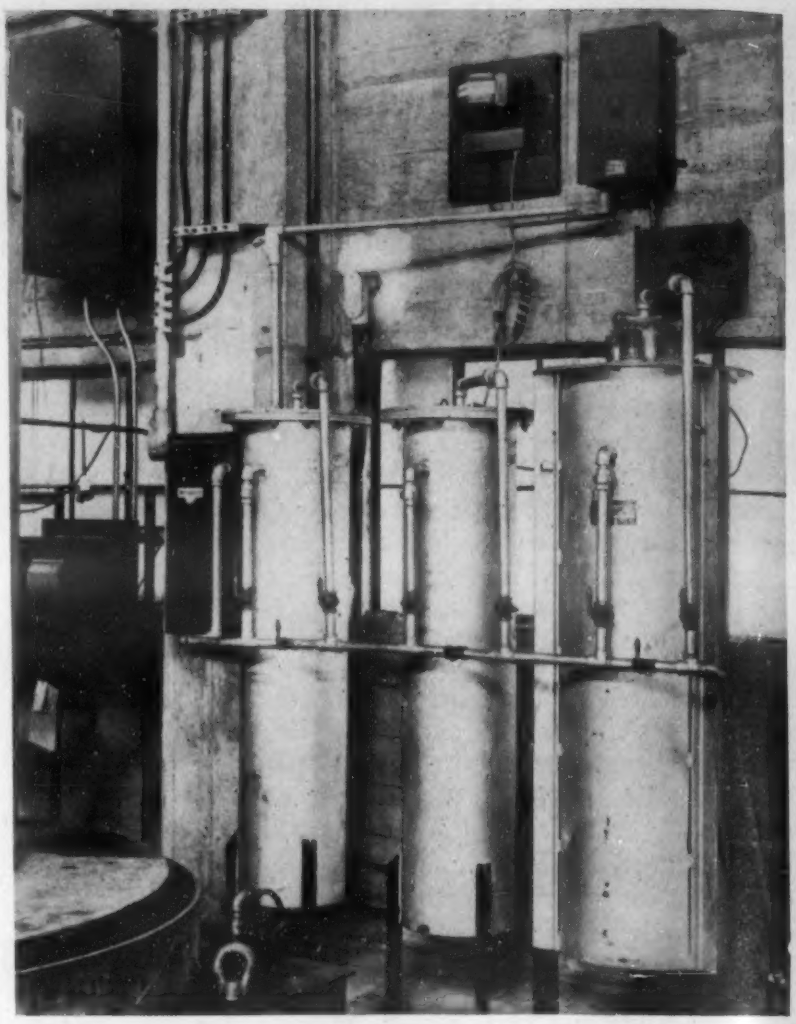


Fig. 20. Equipment for Removing Oxygen and Sulphur (by Passage over Hot Cast Iron Chips) from Natural Gas or City Gas, and for Drying by Passage over $CaCl_2$. The hydrocarbon gases, so purified are used for bright annealing in bell-type furnaces, when the temperature is low enough to avoid carbon deposition from cracking. Made by General Electric Co.

Blast furnace gas need not be considered here, as it is only locally available. When available, it would be very cheap. Petty[32] gives a value of 13 cents per M for blast furnace gas.

Pure Hydrocarbon Gases

Natural gas, essentially methane, CH_4, is available in an increasingly large number of industrial districts at prices not far from 50 to 70 cents per M and the higher hydrocarbons, propane, C_3H_8, and butane,

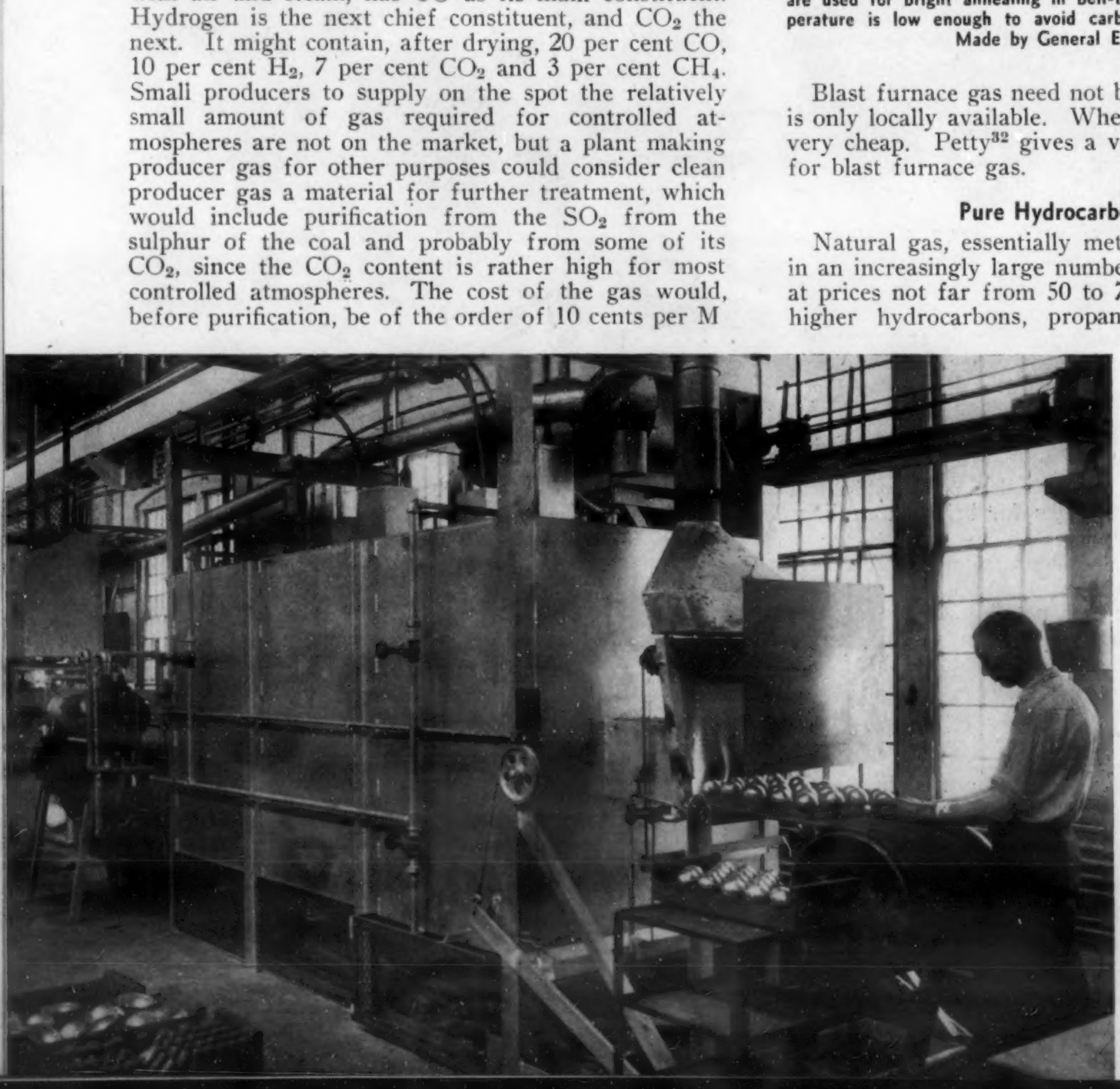


Fig. 19. A G. E. Continuous Copper-Brazing Outfit, also Used for Bright Annealing.

C_4H_{10}, are available as transportable liquids, readily gasifiable, at around 5 and 10 cents per gal. These are all used for gas carburizing, but produce too much soot when the pure gases are heated to be useful for most controlled atmospheres when led directly into the heating chamber.

One plant used, as an atmosphere for box annealing, natural gas passed over hot charcoal to remove any free oxygen and through H_2SO_4 to remove moisture. But this deposited carbon on the sheets, especially on silicon sheets and a partly burnt gas, giving about 5 per cent CO_2, 10 per cent CO had to be resorted to. They can all be cracked, and some of the carbon deposited so that the remaining gas consists chiefly of CH_4 and H_2. Oil or gasoline can be similarly cracked.

While "natural gas" is ordinarily thought of as chiefly methane, it varies in composition in different localities. Schultz[33] shows analyses ranging from 99.5 per cent CH_4 and 0.1 per cent C_2H_6 for West Virginia gas to 59.8 per cent CH_4, 37.6 per cent C_2H_6 for New York gas.

City gas will also vary with its method of manufacture and enrichment, and, while its heating value may be held very constant, its chemical composition may be changed from time to time, even from hour to hour.

City gas passed over hot charcoal, to break down unsaturated hydrocarbons, and then dried over $CaCl_2$, is being used in several plants. Oddly enough it is reported that the traces of oxygen in the city gas are not removed by this treatment. The hydrocarbon gases will be considered hereafter under carburizing. (See Fig. 20.)

(To be continued)

Bibliography (Continued)

19 E. H. Schulz and W. Hülzbruch. "Ueber die Randentkohlung von Kohlenstoffstählen." *Archiv für das Eisenhüttenwesen*, Vol. 1, 1927, pages 225-240.

20 E. G. de Coriolis and R. J. Cowan. "Effect of Atmospheres on the Heat Treatment of Metals." *Industrial & Engineering Chemistry*, Vol. 21, December 1929, pages 1164-1168.

21 C. R. Austin. "Hydrogen Decarburization of Carbon Steels With Considerations on Related Phenomena." *Journal*, Iron & steel Institute, Vol. 105, 1922, pages 93-155.

21a E. D. Campbell. "On the Decarburization of Steel with Hydrogen." *Journal*, Iron & Steel Institute, Vol. 100, 1919, pages 407-414.

22 W. Eilender. "Ueber die Verzunderung und Randentkohlung der Stähle unter dem Einfluss verschiedener Gase." *Gas und Wasserfach*. Vol. 77, Nov. 3 and 10, 1934, pages 757-762, 779-784.

23 P. P. Alexander. "Production of Pure Chromium." *Metals & Alloys*, Vol. 5, February, 1934, pages 37-38.

24 J. F. T. Berliner. "Controlled Atmospheres for Annealing and Welding." *Metal Progress*, Vol. 21, 1932, pages 39-42.

25 R. R. LaPelle and C. H. Carpenter. "Bright Annealing and Normalizing in Controlled Atmosphere Electric Furnaces." *The Iron Age*, Vol. 132, Sept. 28, 1933, pages 28-31, 78.

26 O. Eisenhut. U. S. Patent 2,000,224.

27 C. R. Austin. "Heat Treatment in Controlled Atmospheres Including Gaseous Carburizing." *Transactions*, American Society for Metals, Vol. 23, March, 1935, pages 157-184.

28 A G. Robiette. "The Heat Treatment of Steels in Controlled Atmospheres." *Iron & Steel Institute & British Foundryman*, Vol. 8, 1934, pages 109-114.

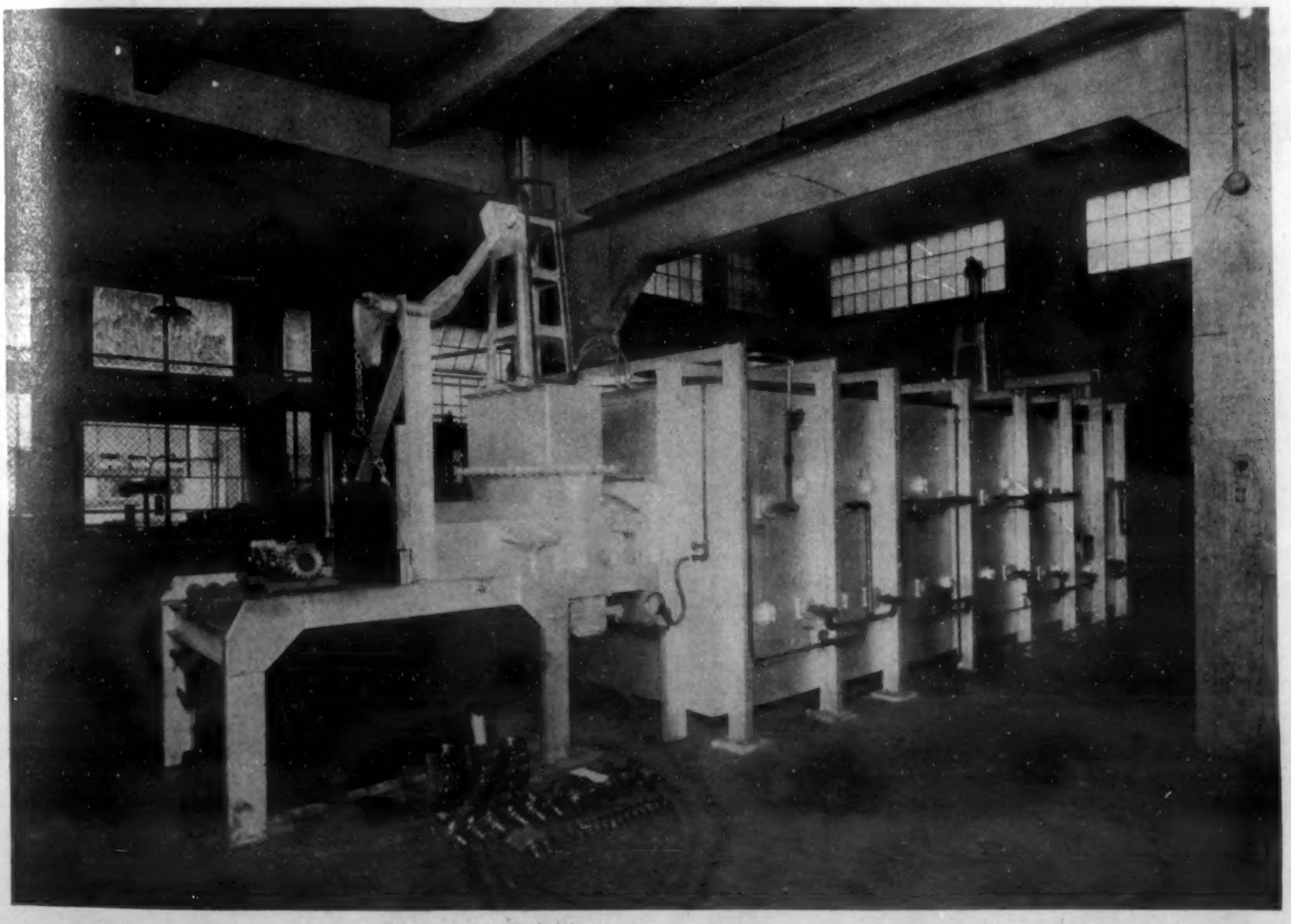
29 H. M. Webber. "Copper Brazing in Controlled Atmosphere Furnaces." *Metals & Alloys*, Vol. 2, November, 1931, pages 284-287.

30 C. L. West. "Copper Brazing." *Metal Progress*, Vol. 24, July, 1933, pages 44-47.

31 A. L. Boegehold. U. S. Patent 1,991,539.

32 D. M. Petty. "The Economic Importance of the Replacement of Obsolete Equipment in Steel Mills." Advance copy, May, 1935, 20 pages.

33 R. S. Schultz. "Combustion Economy in the Rotary Kiln. Part 6. Combustion of Natural Gas." *Rock Products*, Vol. 38, May, 1935, pages 32-33.



A Continuous Gas Carbonizing Furnace of Surface Combustion Co for Drill Bits at the Plant of the Reed Roller Bit Co., Houston, Texas.

EDITORIAL COMMENT

(Continued from page A-47)

of the bearing problem but most of them try to get out of their troubles by going to another maker of bearings, or trying some other type of alloy, without going to the base of the problem and endeavoring to evaluate the measurable properties that are really needed in the particular bearing service.

That type of engineering thought, and the development of reliable methods of measurement of the properties that really make a bearing suitable, seem badly needed. Development of new alloys by the metallurgist and trying them out on the public and, if they don't stand up, shifting to something else, is one way of getting the result, but it is not likely to lead to as certain or satisfactory a result as if the user would state, and definitely prove, just what properties the bearing should have and then let the metallurgist cooperate in evolving alloys to meet those specifications as closely as nature will allow.—H. W. G.

The Foundry of the Future

IF the predictions of one of the representatives of a large seller of alloy-producing raw materials are realized, then within the next twenty years the American foundry industry will be radically altered. Addressing a recent technical meeting in the Middle West, the speaker said that, in the foundry of the future, alloys will be much better understood and more widely used than at present. "By 1950, the non-alloy-minded foundryman will be non-existent. Waste will be cut to a minimum by rigid inspection of all raw materials" by the use of such methods as X-ray analysis, the spectroscope, high-power microscopes and electroanalysis. In the views of this optimistic metallurgist —"The foundry of the future will be completely air-conditioned to eliminate dust and to equalize temperatures. Lighting will be automatically controlled by photoelectric cells. Through the use of mechanical equipment, much of the hard labor associated with the foundry will be abolished."

Probably the speaker was visualizing the gray iron foundry in particular, with possibly the steel foundry included—so far as alloying is concerned. In gray iron, the use of alloys has transformed this old product from a partially discredited engineering material to one possessing properties not thought possible less than thirty years ago. In this regeneration high temperature melting and heat treatment have been vital factors.

In steel, there has been a constantly increasing use of alloys until heat-treated alloy steel castings are today widely used and favored as engineering materials. Both alloy iron and steel castings, suitably heat-treated, are being substituted for forgings in important applications. Witness the alloy iron crankshaft for Ford cars.

As to alloys in malleable castings, here the field thus far has been limited. Chromium in malleable iron castings has found some enthusiastic advocates while others dispute its usefulness. Doubtless here, as in other foundry products, more "alloy-mindedness" will be successfully developed.

As to the prophesies regarding working conditions —air-conditioning, controlled lighting, and so on— these possibly highly desirable aims are hardly attainable in the industry generally at present or until demand for the products of the foundry reach a volume that will insure a profit far beyond anything thus far realized, even in boom times. Good working conditions though, are likely to be a source of profit. There are instances where some of these desiderata are being realized. A mid-western foundry heats the plant with a ventilating system in the winter and pulls in a lot of outside air, keeping the windows closed, in hot weather. Now that leaded bronze is being poured, extreme precautions are being taken to remove the lead fumes—ladles are hooded and a stack carries the fumes up to the hood and exhaust over each pouring station. The plant is also so mechanized that much of the hard labor is really abolished. In more and more foundries the shake out is being provided with an exhaust. It is not impossible to make the foundry almost as free from dust and smoke as a machine shop.

These examples may be prophetic of the future. Metallurgically, however, advances have been rapidly made and more will come, even to the extent of overcoming, at least partially, the competition of welded products.—E.F.C.

A Letter to the Editor

Electrolytic Determination of Ti, Zr and Al

To the Editor: As a subscriber to METALS & ALLOYS, I should like to take advantage of the invitation appearing in the June number (page 156) to comment upon the value of articles which emphasize the analytical aspects of metallurgy.

My own reaction to the article by Mr. Kar on the use of electrolytic methods in the determination of titanium, zirconium and aluminum is very favorable. The article is not only of interest from a purely scientific point of view but it shou'd save much time and money in the analytical laboratory.

I hope you will allow me to make one suggestion. I feel that the usefulness of Mr. Kar's article would have been considerably increased if greater care had been used in describing the conditions of the electrolysis. Allow me to give two examples to illustrate my point:

(1) The power is supplied by a $\frac{1}{16}$-in. thick platinum wire sealed in a glass tubing. The author obviously means that the electricity is led to the mercury cathode through a platinum wire which has been sealed into a piece of glass tubing. As you know, power is supplied by generators, batteries or other sources of e.m.f.

(2) In such an electrolytic process the cathode current density is frequently of great importance. In this article the cathode current density may only be determined from the two statements which occur some distance from one another: "Filter into a 200 c.c. tall electrolytic beaker . . ." and ". . . electrolyze at 4 amp." If an analyst, in trying the experiment for the first time, were to use another type of beaker, he would have an entirely different current density and might easily obtain different results. It would be preferable to state the current density concisely in terms of amperes per square inch or per square centimeter of cathode area.

Lecturer in Electrochemistry, Columbia University, New York RAYMOND R. ROGERS.

THE METAL-CASTING INDUSTRY

By H. L. CAMPBELL

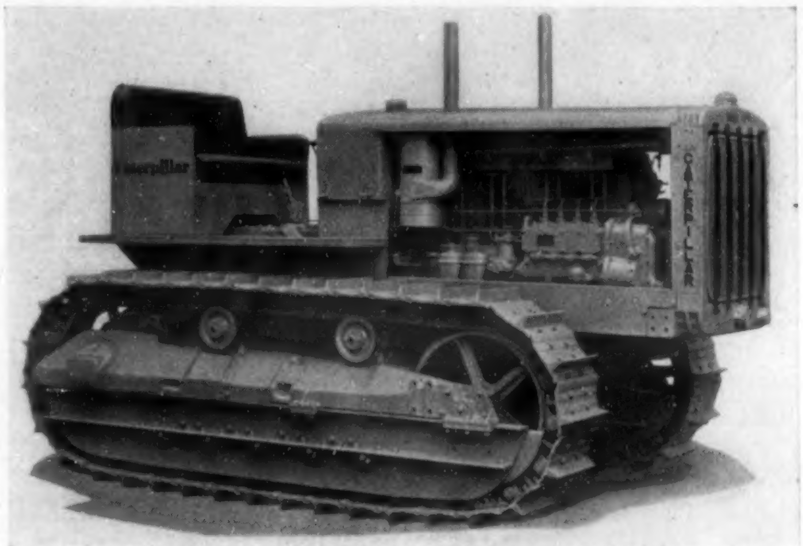
Associate Professor of Metal Processing, College of Engineering University of Michigan, Ann Arbor, Mich.

THE ORIGIN OF THE CASTING method for obtaining metal products is obscured in prehistoric times. It is probable that the first castings were made of gold or copper because these metals were found in a free state. Molds of stone or clay possibly served to form the outlines for the earliest cast articles. The art and science of this method of shaping metals in the liquid state have been in process of development through many centuries, and the applications of the product have become so extensive that an industry of tremendous magnitude has grown up to meet the requirements.

In "The History of Iron and Steel," G. E. Thackray states: "As far as we can learn, the first real operating iron works in this country was established in Lynn, Mass., in 1643 to 1645. As the country developed and became more settled, other iron works were started and operated in New York State, Connecticut, and New Jersey, there being 76 iron works in Massachusetts in 1774." The early blast furnaces used ores from nearby sources and charcoal for fuel. The metal from these furnaces was poured directly into molds for stove plate, kettles, andirons, baking pans, and other household articles. It was not until 1820 that the cupola furnace came into use in the United States. This method of melting gradually replaced the small blast furnaces for the making of iron castings. For many years the cupola furnace has been the most extensively used melting unit for gray iron castings.

Another division of the casting industry is the manufacture of malleable iron castings. This process as used in America was originally devised by Seth Boyden at Newark, N. J., in 1826. The entire practice for making malleable iron castings has been developed gradually through the control of the melting, molding, and annealing operations.

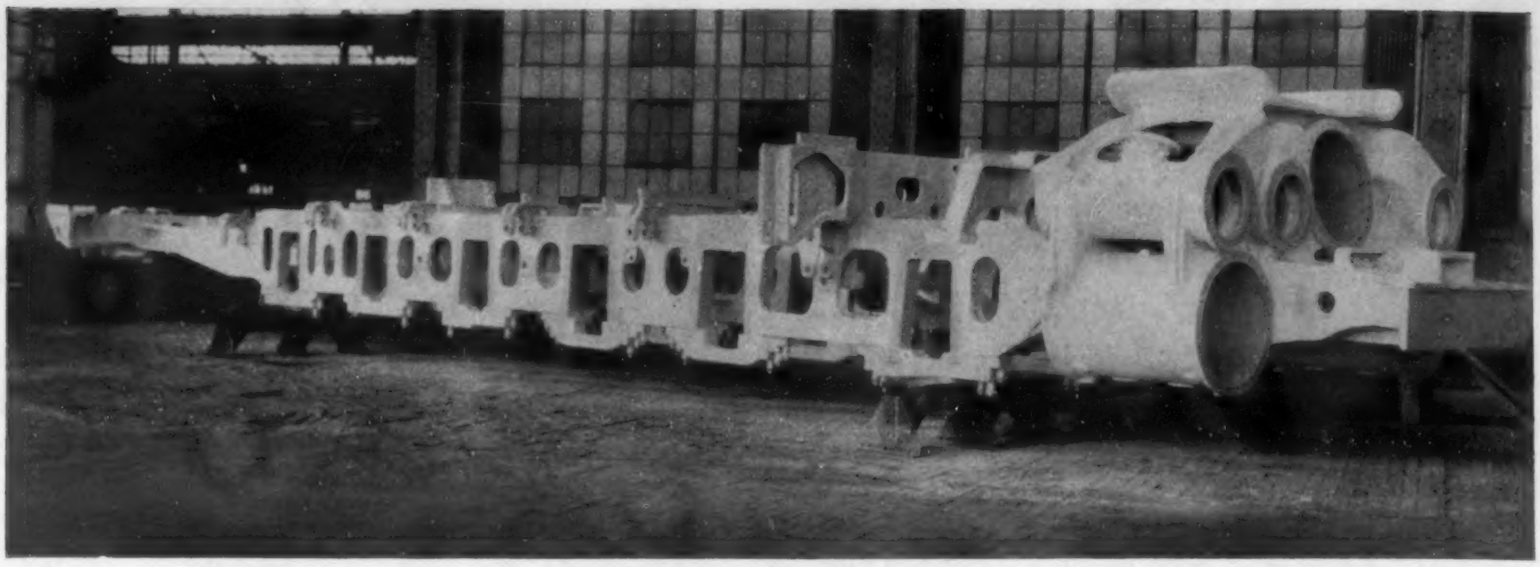
The production of steel castings necessarily followed the developments in the steel-making processes. The first company to make steel by the Bessemer process was organized in 1866. Later, a number of works for the making of converter steel was built in the United States. The Siemens furnace for open-hearth steel was used in England about 1868. Two years later the first successful open-hearth furnace in America was built at Boston, Mass.



A Representative Tractor. (Courtesy of Caterpillar Tractor Co.) About 53 per cent of its weight is metal castings.

Extent of the Casting Industry

A survey recently completed by *The Foundry* (June 1935) shows a total of 5,080 foundries in the United States. Engaged in this industry are 3,215 plants producing gray iron castings, 147 producing malleable iron



A Cast Steel Foundation Frame for a Railroad Locomotive. (Courtesy of General Steel Casting Co.)

castings, 319 producing steel castings, and 2,574 producing brass, bronze, and aluminum alloys. It is evident that some foundry enterprises produce several types of metal castings.

The total tonnage of gray iron castings produced annually in the United States is indefinite. It has been estimated, however, that over 15,000,000 tons of iron castings are produced each year. Some foundries melt as high as 2,000 tons of metal daily for automotive castings. In a normal year, approximately 20,000,000 chilled-iron car wheels are in service in the United States, each running an average of 10,000 miles in one year. The annual replacement of chilled-iron wheels for freight cars is normally about 3,000,000.

The American Iron and Steel Institute has reported a total production of 484,683 tons of cast iron pipe for 1933. The total production of malleable iron castings as reported by the U. S. Department of Commerce for 1931 was 311,853 tons. This amount is only a small fraction of the possible capacity of malleable iron plants in the United States. The yearly capacity for the production of steel castings in the United States has been estimated by the Steel Founders' Society of America to be 2,298,506 net tons. In 1933, the quantity of brass and bronze castings produced in the United States amounted to 73,086,627 lb. as reported by the U. S. Department of Commerce.

A few examples will serve to point out the importance of metal castings in the construction of modern machines. The crawler shovel, as illustrated, weighs approximately 115,000 lb. Of this total weight, 45 per cent is made of carbon steel castings, 22 per cent of alloy steel castings, 10.3 per cent of iron castings, and 1.4 per cent of bronze castings. At least 78 per cent of the weight of the materials used in building this shovel was produced in the foundry.

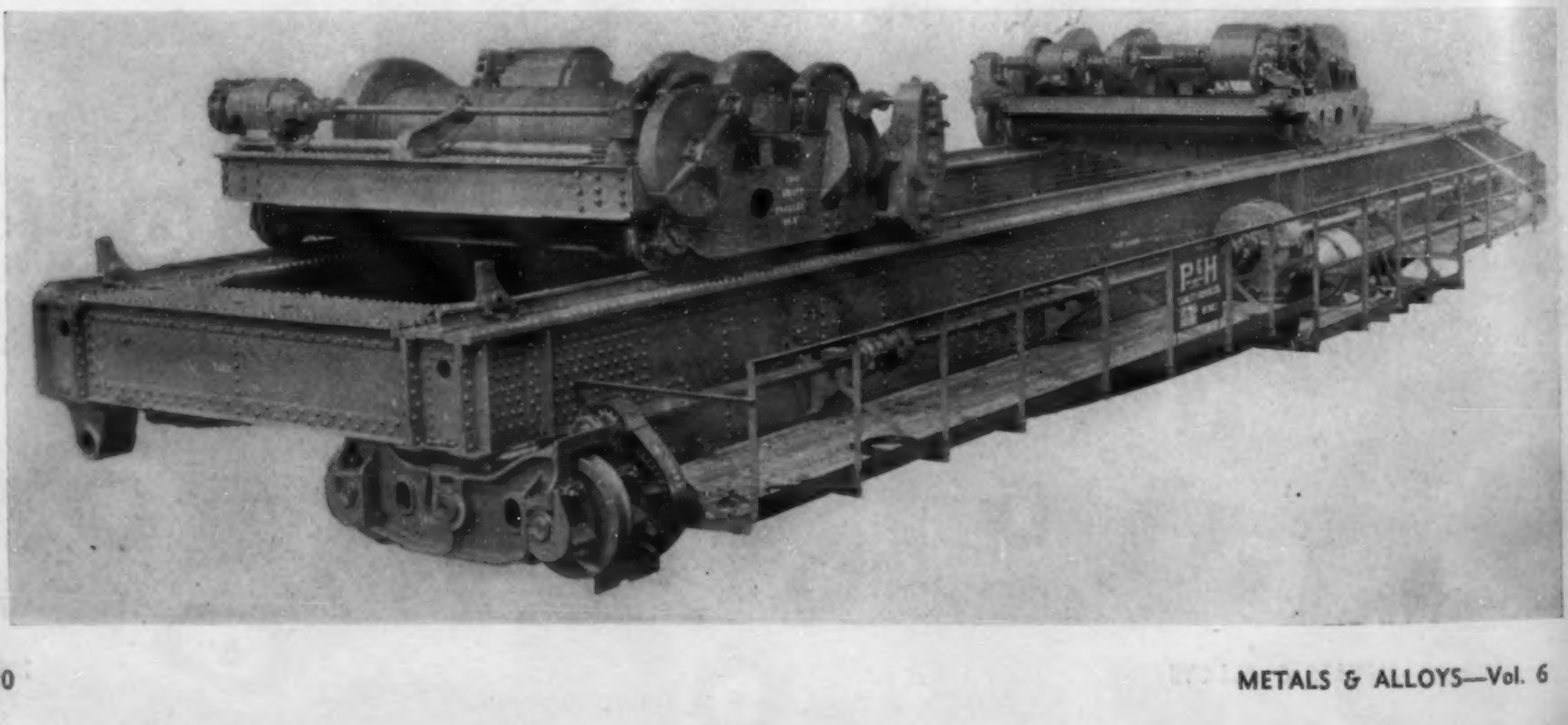
The tractor shown in another illustration contains 6,375 lb. (188 pieces) of gray iron castings, 1,865 lb. (105 pieces) of malleable iron castings, 1,775 lb. (23 pieces) of steel castings, and 100 lb. (64 pieces) of brass, bronze, and aluminum castings. In the construction of this machine, 53 per cent of its total weight is made of metal castings.

The overhead travelling crane shown in one of the illustrations weighs 320,000 lb. and has a lifting capacity of 400,000 lb. The construction of this crane required 52,550 lb. of steel castings used in the bridge trucks, side frames of trolleys, and for gears, and 19,900 lb. of gray iron castings used in the gear covers, hoisting drums, and other parts. About one-fourth of the entire weight of the structure is made of metal castings.

Developments in the Casting Industry

Improved physical properties and greater reliability of the metal in castings are the result of close atten-

A Large Travelling Crane. (Courtesy of Harnischfeger Corp.) Approximately one-fourth of the weight of this crane is made up of castings of metal.



tion to materials and plant processes. It is generally recognized that chemical control is essential to all metallurgical practice. A better understanding of furnace practice is resulting in an improvement in the qualities of the foundry product. Furthermore, the accurate control of molding materials and cores aids in the economical production of metal castings.

The general use of mechanical equipment in the foundry has made possible a remarkable increase in production with a corresponding decrease in unit costs. A superior product has been obtained by the use of better pattern and molding equipment, by improved sand handling and mixing machinery, and by conveying systems for metal and molds.

One of the most marked advances in the ferrous casting division of the industry within recent years is the use of special alloys in steel and cast iron. The valuable properties obtained by special alloy combinations has resulted in extending the use of these new

A Typical Cast Iron Pipe Line. Diameter of the pipe is 36 in. and length of the line, 25 miles. (Courtesy of the Cast Iron Pipe Research Association.)

products. Some machine parts which have been made regularly of forged steel are being replaced successfully by alloy cast iron. In the field of corrosion-resisting and heat-resisting castings, alloys containing chromium and/or nickel have found extensive outlets for industrial equipment.

In the non-ferrous casting division, improvements have been brought about as the result of the availability of purer metals, the use of new alloy combinations, and better melting practice. The present tendency at many foundries is to decrease the number of alloys produced, and to standardize on a few specific types. Die-casting applications are growing in volume and importance as a result of the use of superior alloys and improved casting equipment.

Special attention is being given to the design of castings so as to obtain the full benefit of the properties of the cast metals, and to facilitate the casting of

A Crawler Shovel. (Courtesy of Link Belt Co.) At least 78 per cent of the weight of materials in this shovel is made in foundries.

these materials. In some cases, castings are being redesigned in order to obtain lower cost of production and better service conditions.

The progress made in the casting industry has been due in part to the development and standardization of testing procedure for establishing the qualities of the cast metals, foundry sands, and sand binders. Chief among the agencies which have sponsored this development work is the American Foundrymen's Association.

A 48-in. Cast Iron Pipe Line Strung Along the Right of Way of a 20-Mile Installation.

From a Drawing by Charles Perry Weimer, New York

Copper Stools for Ingot Molds—II

By CLYDE E. WILLIAMS and H. B. KINNEAR

Director and Metallurgical Engineer, Respectively, Battelle Memorial Institute, Columbus, Ohio

IN THE FIRST INSTALLMENT of this article, in METALS & ALLOYS, *July, 1935, the authors discussed various phases of the manufacture of copper stools, including the method of casting, the type of copper used, the design of the stool, laminated stools and copper inserts. This, the concluding section of the discussion, deals with certain economic results of the use of copper stools, including quality of the ingot, mold life and copper molds.*

Economics of Use of Copper Stools

ON THE ASSUMPTION that copper stools are made at the copper refineries and that the used stools will be returned to the refinery for credit, we estimate that, without crediting the copper stool with its longer mold life, saving in stripping labor, and other advantages, copper stools will have to give six to eight times the life of iron stools to pay. This means that, on the average, the copper stool should last at least 500 heats.

The first stool put into commercial use has gone over 1500 heats, 900 on one side and 600 on the other. These are illustrated in Figs. 9 and 10. Many others are still in service with approximately 500 heats to their credit, so there is no question but that in ordinary service copper stools will be economical. In these instances the stools are massive (not laminated) and thermal cracks have not been peened, nor have steel plates been placed on the stool to take the initial impact of hot metal. By utilizing these precautions, or by using a much thicker stool than recommended above, still longer life can be obtained.

Ingot Quality

As far as it has been possible to determine, the use of copper stools has not adversely affected quality of ingots. Of the many tons of steel cast on copper stools, a careful survey of inspection reports have shown rejections to be normal. Structurally, rimming-steel ingots cast on copper and iron stools are alike. This was shown by splitting rimming-steel ingots, 22 x 24 x 72 in. in size, cast from the same heat on the two types of stools. Each showed the same skin thickness and area occupied by the secondary blow holes. Sections of these split ingots are shown in Figs. 11 and 12.

The butts of ingots cast on copper stools remain comparatively flat through the life of the stool. Even after copper stools have been used for several hundred heats, the butts of the ingots are much cleaner, smoother, and flatter than those cast on iron stools and never assume the extreme bulged condition so often seen on ingots poured on cast-iron stools.

Increased Mold Life

Plant tests show an increased life of molds of from 30 to over 100 per cent when copper stools are used. This may be attributed to the more rapid abstraction of heat from the steel by the copper stool. This

Fig. 9. "Old No. 1." The First Copper Stool Put in Service. After 600 heats on one side of the stool was turned over and 900 more made upon it. This shows the surface after 900 heats. The stool is being continued in use.

Fig. 10. "Old No. 1." After 600 heats on the Reverse Side.

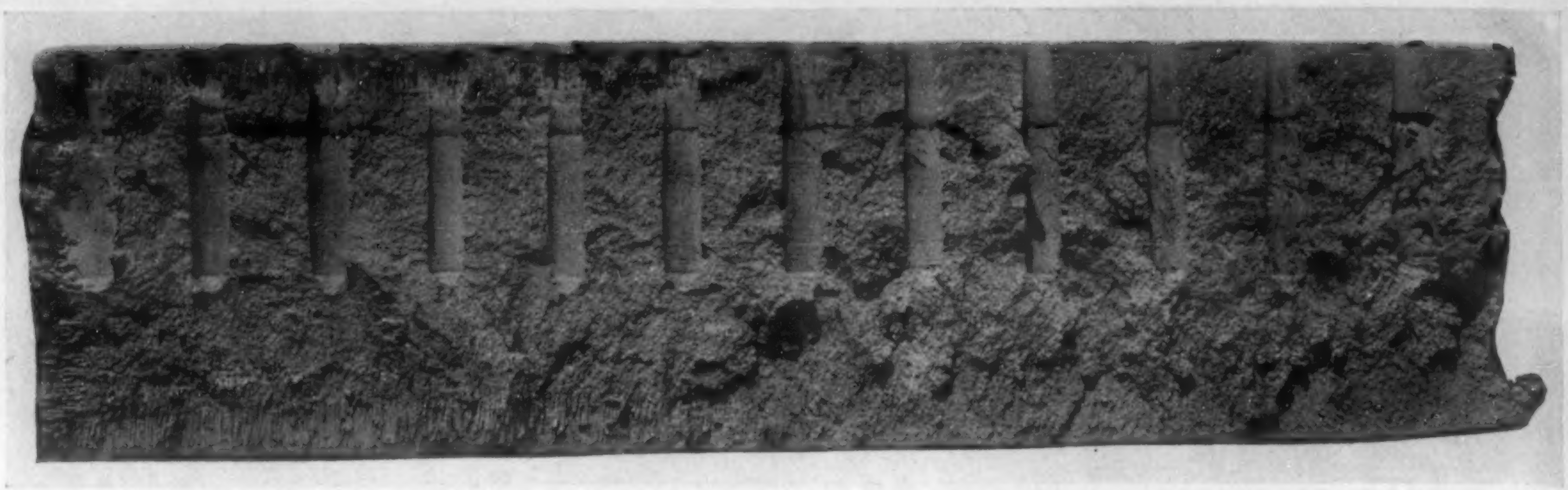


Fig. 11. Cross-Sectional Structure of 22-in. Side of Ingot on Iron Stool.

causes the steel in the lower section of the mold to cool more rapidly and to freeze earlier, and thus establish the gap between ingot and mold more quickly, both of these actions serving to hold down the inside surface temperature of the lower section of the mold. The greater clearance at the butt end of the ingot results in easier stripping, fewer stickers, and hence less rough usage of the mold. These effects also should permit earlier stripping which would still further lengthen mold life.

Although plant records are not complete, they indicate that the use of copper stools lengthen the life of mold buggies. That this should be the case is indicated by the fact the tests described below show that the copper stool never reached as high a temperature initially as the iron stool and also cooled off more quickly.

Stool and Mold Temperature Measurements

In order to find out what the thermal conditions in stool and mold actually are, temperature measurements were made on stools and molds. The dimensions of molds and stools and the location of thermocouples are shown in Fig. 13. The thermocouples with hot-junctions in positions shown by circles bearing numbers from 1 to 15 were inserted through small holes drilled to a depth, "d," into either the walls of the mold or into the bottom side of the stools. Values for "d" of holes drilled in the mold are given in Table I and of holes drilled in the stools are given in Table II.

The deep-seated thermocouples situated close to the ingot, for measuring the higher temperatures, were marked with even numbers; the shallower couples, located at the outer surface were marked with odd numbers. All were wedged in position to eliminate displacement during the tests. The thermocouple leads passed through asbestos covering and then into flexible steel tubing for protection against injury from metal splashes. They then entered a cold-junction box and finally connected with two switches and two portable potentiometers. The lower temperature reading thermocouples with odd-number designations were read with one potentiometer, while the even-numbered or higher-temperature-reading couples were read with the other. This scheme avoided larger temperature differences between couple readings; hence made reading easier and more rapid.

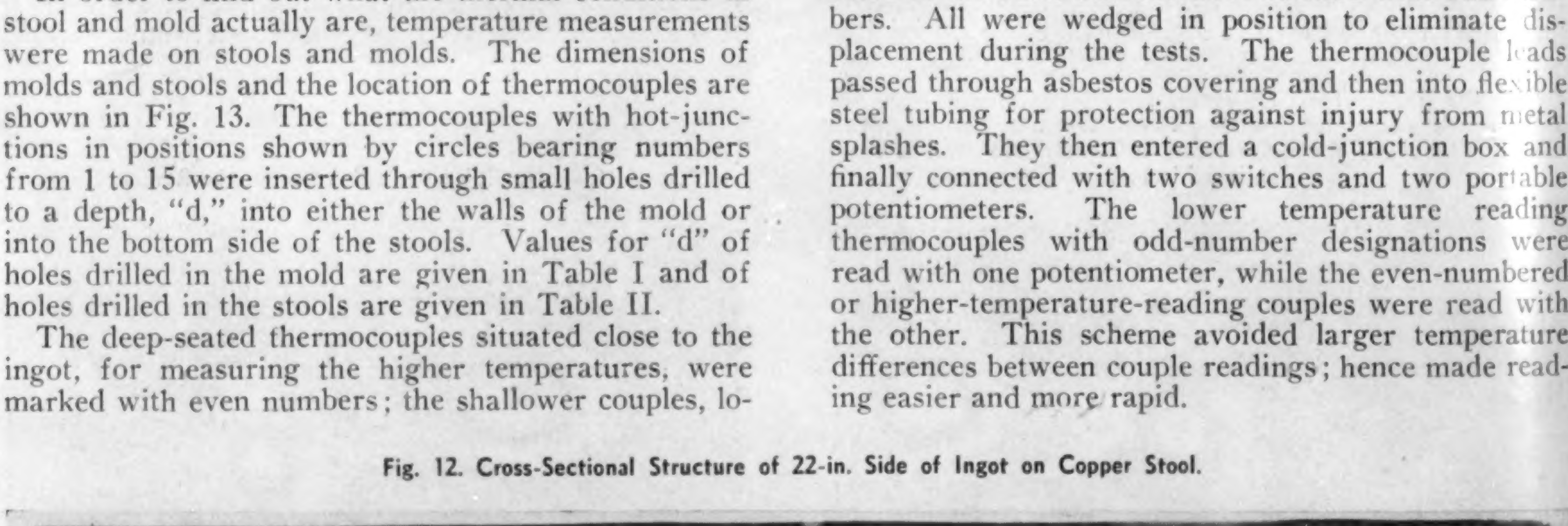
Table I. Location of Thermocouples in Mold

Thermo-couple No.	Distance from Bottom of Mold, In.	Depth of Hole "d," In.	Calculated Distance from Inner Surface, In.
1	46	1 1/16	—
2	46	6 5/16	1
3	30	1 1/16	—
4	30	7 1/16	1 7/16
5	14	1 1/8	—
6	14	6 13/16	1 1/2
7	6	1 1/8	—
8	6	7 5/8	9/16
9	2	1 1/8	—
10	2	6 13/16	1 11/32

Table II. Location of Thermocouples in Stools

Thermo-couple No.	Distance from Edge of Stools, In.		Depth of Holes "d," In.	
	Cast Iron	Copper	Cast Iron	Copper
11	18 1/2	19	1 1/8	1 3/16
12	19 1/4	19 3/4	7 5/8	9 5/[illegible]
13	11	11 1/2	1 1/8	1 3/16
14	11 3/4	12 1/4	7 1/2	9 1/2
15	4	5	1 1/16	1 1/4

Fig. 12. Cross-Sectional Structure of 22-in. Side of Ingot on Copper Stool.



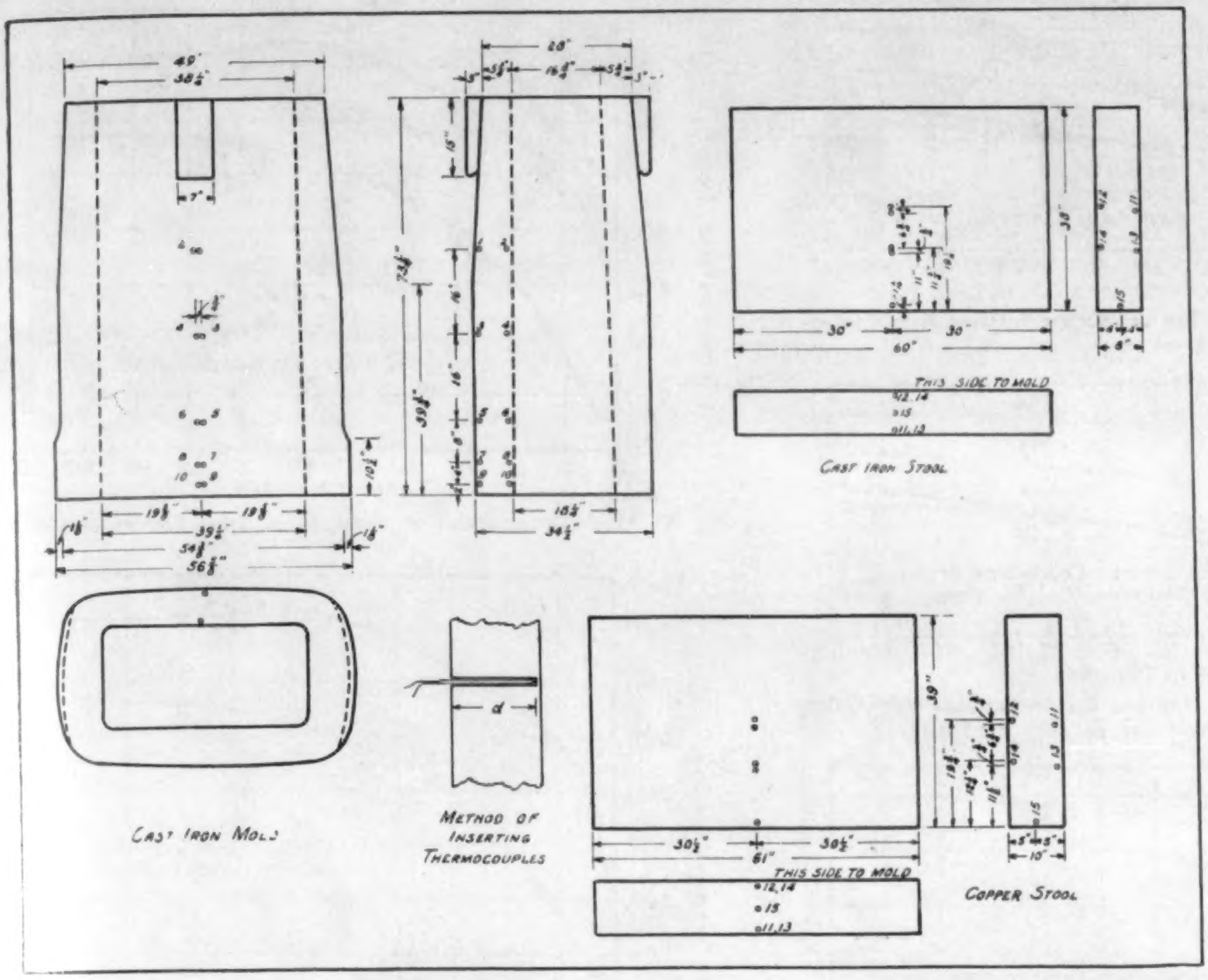


Fig. 13. Approximate Mold and Stool Dimensions and Locations of Thermocouples in the Mold and Stools.

Photographs of the arrangement of thermocouples in the mold and stool and of the cold-junction box, switches and potentiometers are shown in Figs. 14 and 15. It will be noted that short bolts were driven into the corners of the copper stool just outside the space occupied by the mold to center it and keep it in place. A cast iron stool of the size used in the test is shown to the rear of the copper stool.

Fig. 14. Photograph of Arrangement of Cold-Junction Box, Switches and Potentiometers Used in Measuring Temperatures. On pouring platform back of sheet-metal wall.

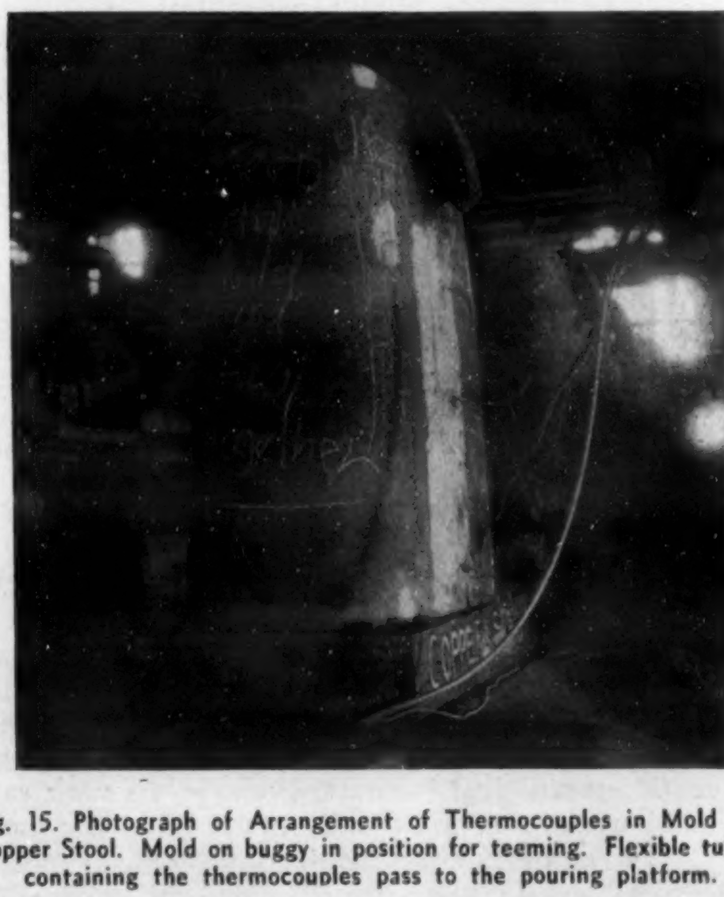


Fig. 15. Photograph of Arrangement of Thermocouples in Mold and Copper Stool. Mold on buggy in position for teeming. Flexible tubing containing the thermocouples pass to the pouring platform.

Thermocouple leads from the stool are shown coming from beneath and passing through flexible tubing to the pouring platform where they are connected to the temperature-measuring instruments. Thermocouples from the mold are brought together through a separate flexible tube onto the pouring platform where they are also connected with the temperature-measuring instruments.

Two tests were made, both with the same cast iron mold, once on a cast iron stool and once on the copper stool. In both cases 11,200 lb. of metal was poured at

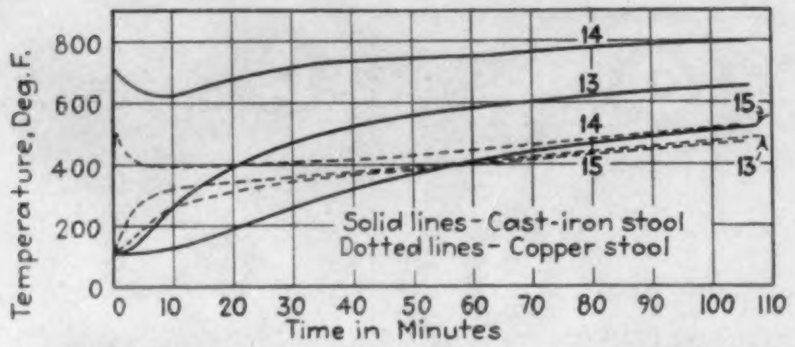


Fig. 16. Stool Temperatures at Top and Bottom Surfaces Near Center-Line of Stool.

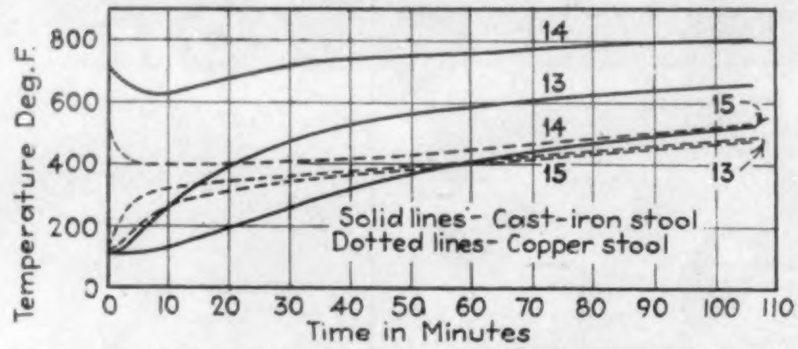


Fig. 17. Stool Temperatures at Top and Bottom Surfaces Near Outer Area Covered by Ingot and on Edge of Stool.

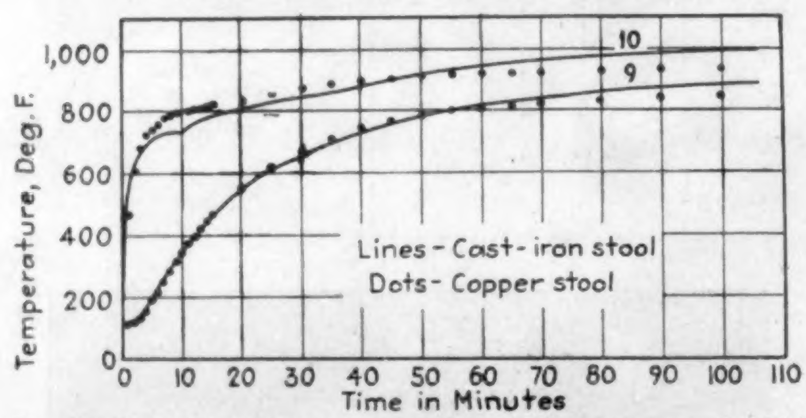


Fig. 18. Mold Temperatures at Level 2 in. from Bottom of Mold.

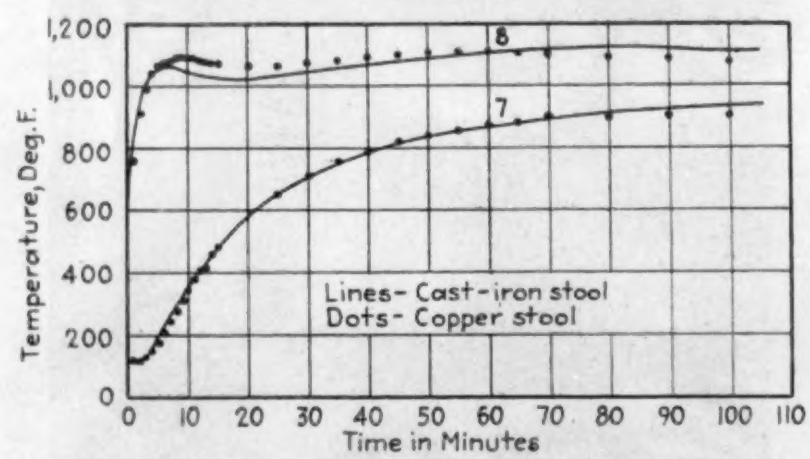


Fig. 19. Mold Temperatures at Level 6 in. from Bottom of Mold.

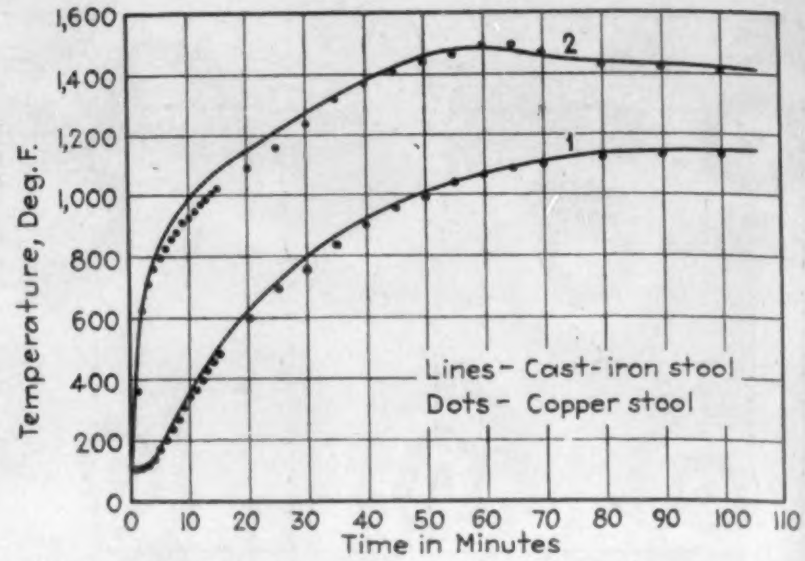


Fig 20. Mold Temperatures at Level 14 in. from Bottom of Mold.

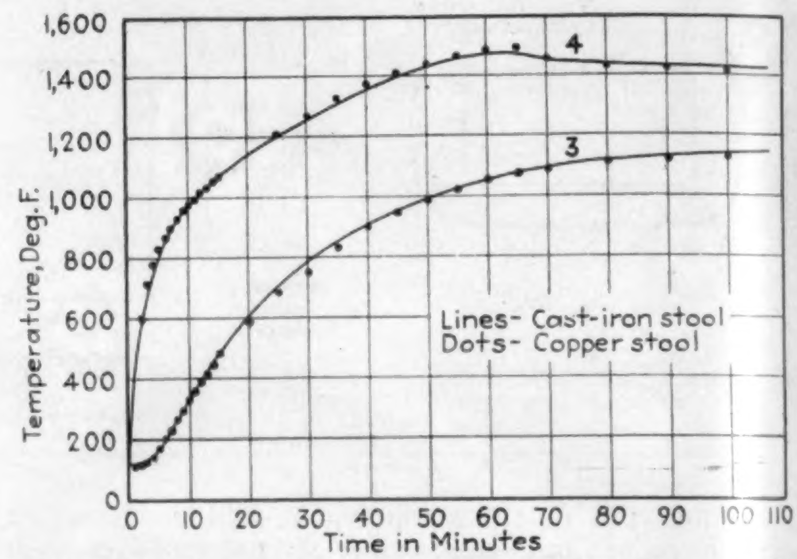


Fig. 21. Mold Temperatures at Level 30 in. from Bottom of Mold.

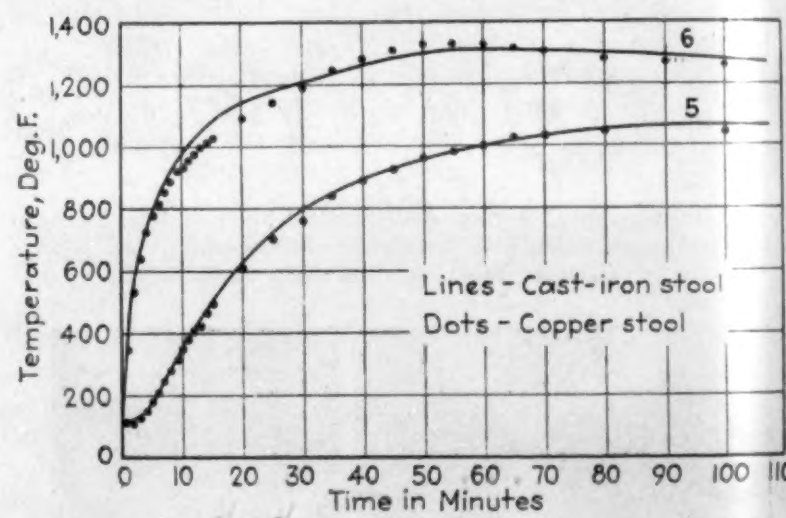


Fig. 22. Mold Temperatures at Level 46 in. from Bottom of Mold.

2845 to 2850 deg. F. The temperature was determined by sighting an optical pyrometer sighted on the metal stream just below the nozzle. In each case the mold was the seventh to be poured and the mold and stool were warm from the previous heat. Pouring took 48 sec. on the cast iron stool and 42 sec. on the copper

Stool Temperatures

Temperature measurements at Position 12, which was 3/8 in. from the surface of the stool, at the center where the first metal strikes, and at Position 11, close to the bottom of the stool and directly under Position 12, are shown in Fig. 16.

Position 14, 1/2 in. from the stool surface and at the edge of the area covered by the ingot, Position 13, directly below 14 but at the bottom of the stool, and Position 15, half way up in the stool at the edge of the area covered by the ingot, but on the small end of the rectangle, gave the temperatures shown in Fig. 17.

Fig. 16 shows the huge difference between the stool temperatures with cast iron and with copper directly beneath the center of the ingot, while Fig. 17 shows that there is a large difference at the edges as well. By comparing the curves for all the positions in Figs. 16 and 17, it will be noted that after the first half hour all these different positions in the copper stool were within 60 deg. F. of the same temperature at any moment, while with the cast-iron stool even after 105 min. there was 530 deg. F. spread between Positions 12 and 15.

With the initial shock of the pouring stream the cast-iron stool, measured 3/8 in. below its hottest point, rose to 1500 deg. F., while the corresponding figure

for the copper stool was only 660 deg. F., and, while the cast-iron stool at this position never cooled below 950 deg. F., the hottest part of the copper stool sank below 500 deg. F. in less than 10 min.

Mold Temperatures

Mold temperatures at the 2, 6, 14, 30 and 46-in. levels above the mold bottom were plotted in Figs. 18 to 22. With both types of stools mold temperatures were closely identical throughout at the upper levels and initially at all levels. After a period of time, curves for the 2, 6 and 14-in. levels for the cast-iron-mold-copper-stool arrangement fell below the curves for the cast-iron-mold-cast-iron-stool arrangement. This divergence in temperature was noticed after 50 min. on the 2-in. level, after 60 min. on the 6-in. level, and after 70 min. on the 14-in. level. More heat was drained from the ingot and mold by the copper stool during the first hour.

Isotherms at 10 and 60 min. are shown in Figs. 23 to 26.

It will be seen that appreciable differences occur only at the lower end and that they are most marked at Position 10, which is 2 in. from the bottom and 1 11/32 in. back of the mold face. The temperature at this point becomes stabilized at 60 min. on the copper stool and only at 100 min. on the cast-iron stool. The final mold temperature at this position is 65 deg. F. lower when the mold rests on the copper stool.

It is believed that larger differences in temperature in the lower section of the mold would have been found had measurements been taken at the inside surface of the mold, because heat transfer through cast iron is so slow. The extremely high temperature right at the surface of the mold, rather than the temperature a fraction of an inch in from the surface, is probably the cause of the rapid development of thermal cracks in cast-iron ingot molds.

Contraction Conditions In The Ingot

Since the mold temperatures are practically indistinguishable above the 6-in. level, it is only the very tip of the butt end of the ingot which is more rapidly cooled on the copper stool. But this extreme tip is the location of greatest area of contact with the mold in stripping and is the crucial location, as regards ease of stripping.

The ingot has a slight taper and is actually a truncated rectangular pyramid.

If we assume that the steel ingot itself, at stripping, has on its butt face an average temperature a little above that measured in the stool at Position 12, we might assign to the butt face a temperature of around 1000 deg. F. on the cast-iron stool and 500 deg. F. on the copper stool. A 500 deg. F. difference in temperature means that the 39-in. long dimension of the ingot is about 3/16 in. smaller and the 18-in. short dimension about 3/32 in. smaller when stripped from the copper stool. At 2 in. up, if we assume the average temperature at that level to be that of Position 10 in the mold, with its difference in temperature of some 60 deg. F. lower on the copper stool, the long dimension of the ingot would be between 1/32 and 1/64 in. smaller on the copper stool. Obviously, the butt tip of the ingot has shrunk away from the mold appreciably more on the copper stool and this naturally facilitates stripping. It will probably be feasible to strip earlier from a copper than from a cast-iron stool.

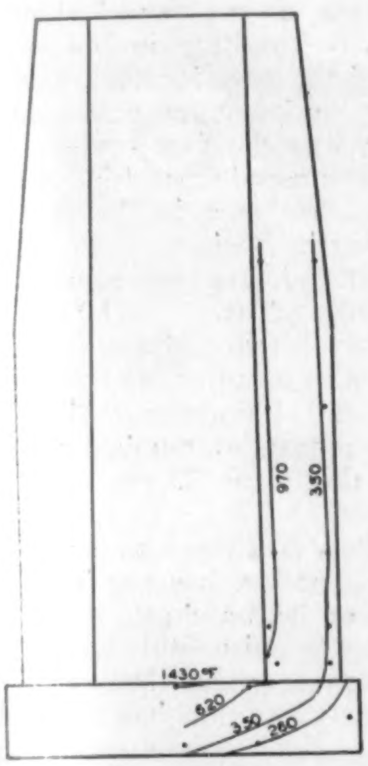


Fig. 23. Isotherms in Cast-Iron Mold and Stool after 10 min. Duration of Test.

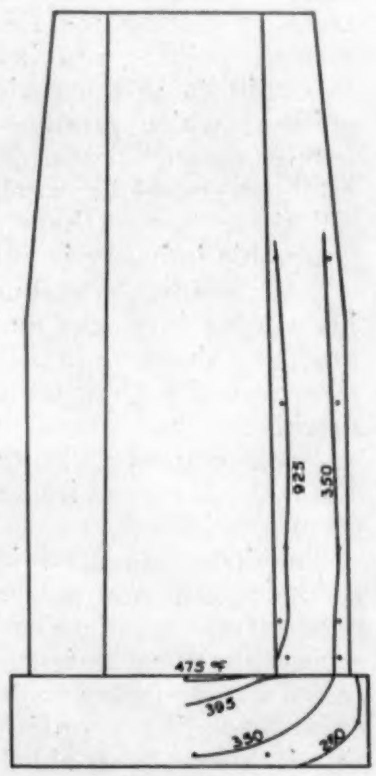


Fig. 24. Isotherms in Cast-Iron Mold and Copper Stool after 10 min. Duration of Test.

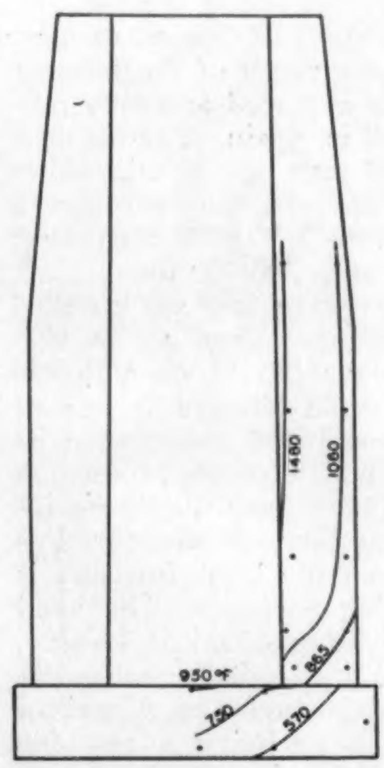


Fig. 25. Isotherms in Cast-Iron Mold and Stool after 60 min. Duration of Test.

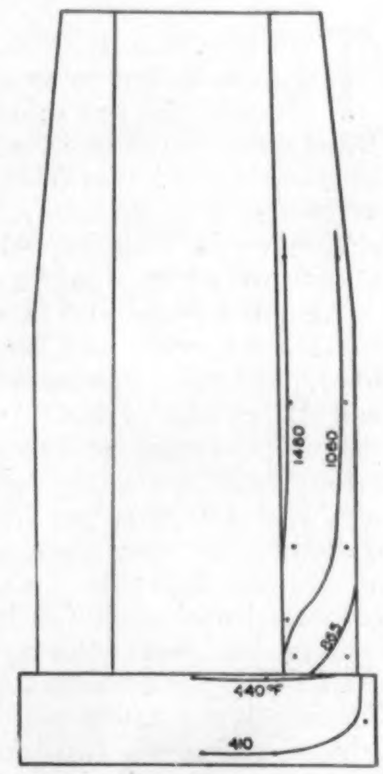


Fig. 26. Isotherms in Cast Iron Mold and Copper Stool after 60 min. Duration of Test.

Copper Molds

EXPERIMENTS with small copper molds up to 7 in. in section indicate that a fairly long life may be expected, that no difficulties attend their use, and that there is some improvement in the ingot surface. A 20-in. fluted big-end-up mold used commercially developed thermal cracks too early to warrant its use. To secure sufficient life of copper molds, changes in design must be developed. Water-cooled molds may be necessary.

Further work is required on mold design and on the effect of copper molds on steel quality, but the success attending the use of copper stools encourages the hope that such work will prove to be worth while.

Status of the Ferrous Metallurgical Industry in Spain

By D. JOSE SERRAT Y BONASTRE*

and

F. R. MORRAL†

THE IRON ORE DEPOSITS of Spain are more than sufficient to supply the needs of the country. Most of the ore mined is exported and only one-third to one-fifth of it is used in Spain. The ore production in 1913 was 9,000,000 tons but, as with other activities, this industry is also passing through a severe crisis, and in 1934 only 2,000,000 tons were mined, of which Spain used only 700,000 tons.

Near the mines and in strategic regions are installed the blast furnace and steel plants. They are in Viscaya, Asturias, Santander, Navarra, Alava, Valencia and Barcelona. Altos Hornos de Viscaya is one of the oldest firms. It has changed and modernized its rolling mill to electric drive, which allows production of 70 to 120 tons per hr. There have also been installed in the steel department three Maerz furnaces of 75 tons capacity. Gas from the blast furnaces is recovered and used for heating purposes. The hand loading has been supplanted by mechanical loading.

La Compañia Siderurgica del Mediterraneo at Sagunto is the latest plant established. An American firm of engineers furnished the technical advice for its construction. This was built during the Dictadura (dictatorship) and, as was the case in many projects of the period, on a very large scale. The actual crisis in Spain is largely due to the mistakes of that period.

The plant at Sagunto has in process of erection a very large installation consisting of four blast furnaces, of which only two are in active service with a daily average capacity of 400 tons. The iron may be used for casting or for steel making. For the latter there are four open-hearth furnaces, each of 80 tons and one of 90 tons capacity. With this equipment, just half of that planned, the capacity of this plant is 900 tons daily. It has a power plant, a complete and modern rolling mill, repair shops, cast iron electric steel and bronze foundries, boiler repair and general construction shops. A by-product coke plant produces benzene, toluene and pure xylene, having a good outlet on the Spanish market for the manufacture of explosives and dyes. This plant provides social institutions, such as sickness and death insurance, a hospital, a cooperative store, a high school, an arts and trade school, a church, a section for villas for the engineers and officials, and also a group of houses for the workers. In normal times this plant affords employment to 4,000 workers (in 1933 to only about 1,000).

The Spanish production of pig iron was very important before the World War. It was exported to Germany, England and Italy. In 1934 it amounted to only 350,000 tons, 0.056 per cent of the world's production (in 1932 it was 0.085 per cent). It is difficult to state the exact number of blast furnaces in operation last year, but there must have been about 20 ready to put in blast, 12 of which actually operated. In 1934 the steel production in the world increased even more than the pig iron production; it was 158 per cent in excess of that of 1932. In Europe, Germany has increased its production 224 per cent in this period. Spain has fallen from the rank of making 1.04 per cent of the world's production of steel in 1932 to 0.66 per cent—533,000 tons were produced in 1932 and 540,000 tons in 1934.

The metallurgical industry in other countries seems to be able to progress and recover from the crisis, but in Spain it does not seem to for several reasons: First, because of financial difficulties of the national treasury during the Dictadura, as mentioned above; second, politics and insecurity resulting in the wish to establish, in the period of the new Republc, social reforms which produce very inopportune economical results during crises. Spain was the first country to establish the 44-hr. week in the metallurgical industry. All these factors have had their part in the severe crisis this industry is suffering in Spain.

The Spanish metallurgical industry represents an investment in stocks and bonds of over 1,069,000,000 pesetas (about $145,000,000), distributed among 230 siderurgical and metallurgical companies, and 300 of machinery and metal working industries. All the workers employed in these industries number about 125,000. A census indicates that about 23 per cent of them are jobless.

The iron and steel industry is always a measure of the wealth and power of a nation, because it is so necessary to communications on land and sea, machinery and national defense. The Spanish State has protected this industry with generous grants, but not the ones depending upon it. This protection has allowed this industry to establish a sort of monopoly and to neglect all improvement and modernization in itself and all other industries dependent on it. This monopoly was held by a small number of rich industrials in the mining regions in the Basque province. This political protection shows plainly today its restrictive effect, since special materials are deficient or non-existent, the ship yards are ruined, the shipping companies are putting their last ships to rest and the railroads are financially unstable. A policy consisting of a leadership of technicians in industry and business should prove of benefit to this country and especially to the metallurgical industry which is one of the most important sources of wealth in a nation.

The State has named some commissions of technicians to study and help in the governing and leadership of industry and business. These have turned in their reports and recommendations to the ministers in charge, who have usually not only neglected them, but legislated exactly the opposite of what was recommended.

A group of friends interested in metallurgy, metallography, machinery, motors, aviation and the like, has formed an association, Instituto de Ia Metalurgia y de la Mecanica, IMM, in Barcelona, to meet once a month and one of the first aims of this society is to establish "standards" which they will try to establish in the whole of Spain. At present there is nothing of the sort in Spain and individual firms have their preferences. The object of this society is to diffuse technical knowledge and try to introduce scientific-technical-economic cooperation in these industries in Spain.

* Consulting Engineer, Barcelona, Spain, former technical director of the Maquinista Terrestre y Maritima.
† Research assistant at the metallurgical laboratory of the Barcelona Unive sity, Faculty of Sciences.

Recent Progress in Steel Making Reported from Germany—IV

A Correlated Abstract

By S. EPSTEIN

Metallurgist Battelle Memorial Institute, Columbus, Ohio

IN THE THREE INSTALLMENTS of this important contribution by Mr. Epstein, published in the May, June and July issues respectively, these topics have been discussed: "Equilibria between Slag and Bath," "Gases in Steel" and "Desulphurization in Basic Open-Hearth Steel." The series is continued in this, the fourth section, which deals with "Defects in Steel." The concluding installment will have as its subject "Some Recent Practical Developments."

DEFECTS IN STEEL

TWO types of defects in steel have received considerable study in Germany recently, namely "sand seams" and flakes. Sand seams are representative of a large class of defects associated with surface seams, inclusions, and banding in killed and semi-killed steel. Flakes or shatter cracks may appear not only in Ni-Cr ordnance steel, in which they first came to notice, but in almost all higher C and alloy steels. The shatter cracks in rail steel which are considered to form the nuclei of transverse fissures are undoubtedly similar to flake.

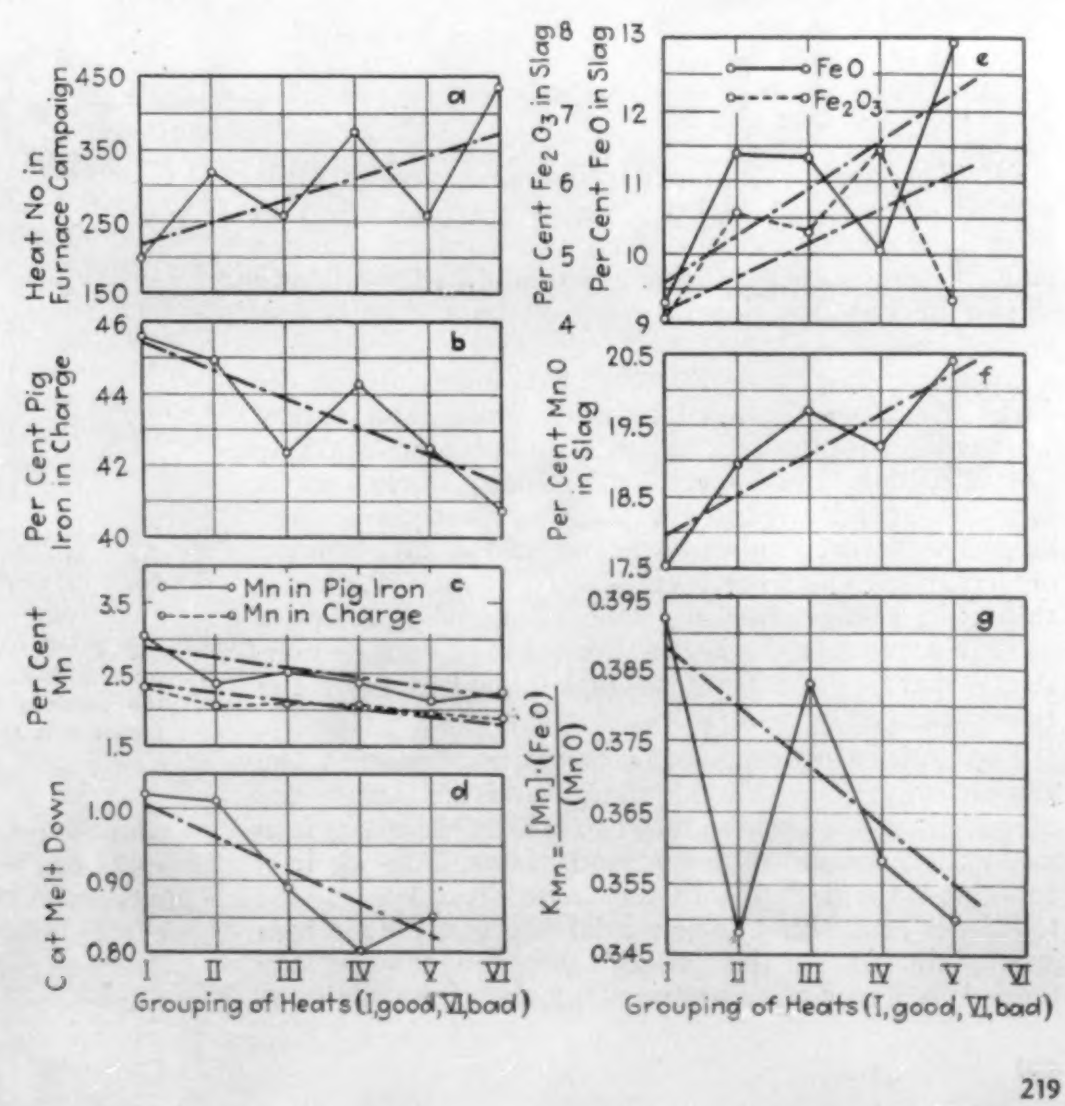
The search for the causes of sand seams among the many variables in the melting and casting procedure was mainly by statistical methods. The even more elusive causes of flakes, the occurrence of which is dependent not only on the melting and casting procedure but also on the subsequent forging and cooling treatments, were studied mainly by metallographic and experimental methods.

Sand Seams

Sand seams are surface (or somewhat more deeply-seated) defects in forgings, such as large railroad-car

Fig. 18. Appearance of Inclusions in Sand Seams. 250 diameters. K. von Kerpely.[35]

Fig. 19. Effect of Variables in the Furnace Practice on the Occurrence of Sand Seams. K. von Kerpely.[35]



axles, that show up on the bearing surfaces after machining as longitudinal seams or cracks filled with refractory oxides. The appearance of the inclusions which may be found in such seams is shown in Fig. 18. Bardenheuer[34] gave the following analyses of inclusions in sand seams:

SiO_2, per cent	Al_2O_3, per cent	CaO, per cent	Fe, per cent	Mn, per cent
36.5 to 60	1.7 to 36.1	0.26 to 1.4	12.3 to 12.7	12.7 to 43.6

Von Kerpely[35] studied the incidence of sand seams

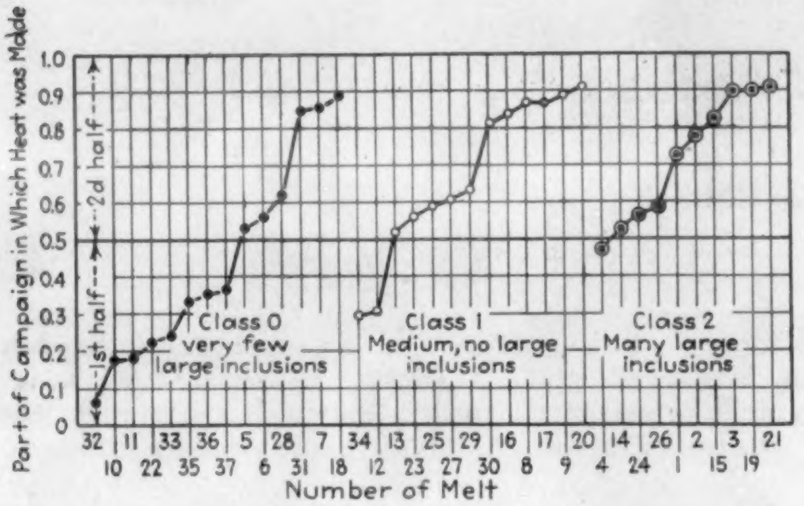


Fig. 20. Effect of Condition of Furnace on the Occurrence of Large Inclusions in Large Forgings. Lotta, Killing, and Sauerwald.[34]

in 40 basic open-hearth heats correlating this with the heat records. The heats were of 30-tons, poured mostly into 9-ton ingots. The steel was plain C of about 70,000 lb. per sq. in. tensile strength and was forged into locomotive crankshafts. The heats were divided into 6 groups as follows:

Good I — shafts showed no sand seams.
II —1 shaft out of heat discarded because of sand seams.
III—2 shafts out of heat discarded because of sand seams.
IV—3 shafts out of heat discarded because of sand seams.
V —4 shafts out of heat discarded because of sand seams.
Bad VI—5 shafts out of heat discarded because of sand seams.

Of 224 shafts examined, 166 were found satisfactory, and 58, or 25.8 per cent, were rejected. Von Kerpely's correlations between the furnace practice and the occurrence of the good and bad heats are shown in Fig. 19. Several very striking correlations are evident.

Thus Fig. 19*a* shows that the heats made later in the furnace campaign tended to show more sand seams. This is likewise brought out in a similar correlation by Lotta, Killing, and Sauerwald[34] of large inclusions in forgings, as indicated in Fig. 20. The reason, no doubt, lies, as is further indicated below, in the fact that an older furnace does not give as sharp a melt-down, resulting in a longer melting time, a sluggish boil, and a more viscous slag, higher in FeO. These data demonstrate that it is difficult to make good steel if the furnace is not in good working order.

Fig. 19*b* indicates a clear correlation between the amount of pig iron in the charge and the occurrence of good and bad heats; those to which more pig iron was added contained fewer sand seams. The pig iron contained about 0.5 to 1.0 per cent Si and about 2.5 to 3.5 per cent Mn. The beneficial effect of the pig iron is explainable on the ground that the Si and Mn tended to lower the O content of the bath; with the higher Si in the charge the CaO/SiO_2 ratio of the slag would be lower, so that it would be more fluid and contain less FeO. The other correlations shown in Fig. 19 are, no doubt, dependent on the same fact; thus a more oxidized bath would give more MnO in the slag after the addition of ferromanganese; more MnO would also presumably remain in the metal. A high Si content would raise the bath temperature and thus produce a more vigorous boil and more fluid slag.

However, having found these correlations between sand seams and furnace practice, the exact mechanism of their formation still remains uncertain. Daeves in discussing von Kerpely's paper held that the more oxidized metal, higher in MnO, had a strong dissolving action on the refractory lining of the runners and ladle. This view seems to be substantiated by the analyses of inclusions in the sand seams which are somewhat similar in composition to the runner and ladle refractories. One might not perhaps expect large differences between heats of ostensibly the same composition in respect to their cutting action on refractories, but somewhat similar ideas have been expressed as to the effect of dissolved O on the "fluidity" of steel castings.[36]

On the other hand, it may be that the steels higher in FeO are simply dirtier and that this dirt is segregated in the seams during solidification. The somewhat more oxidized and hence incompletely killed steel might also show some "action in the mold" or blowiness. That incompletely killed steel is more apt to give seams and ghost lines has been shown by Herty[37] and is also indicated by the work of F. Bardenheuer[38]

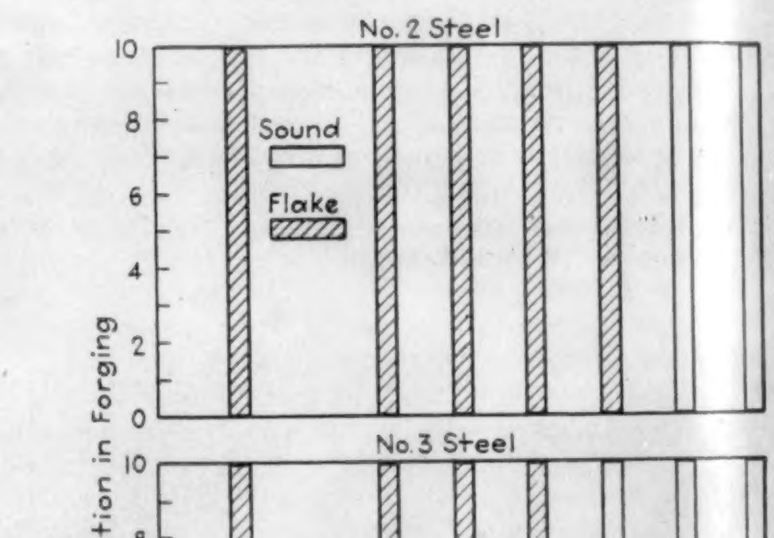


Fig. 21. Temperature of Occurrence of Flake in Forgings. Houdremont and Korschau.[41] The forgings were transferred directly from the finishing temperature to a furnace held at 900 deg. C., then cooled with the furnace and different samples withdrawn at the temperature indicated and air cooled.

who found ghost lines and inclusions to be associated with rows of blowholes. The relationship between "action in the mold" and the segregation of inclusions particularly near the surface of the ingot is undoubtedly a close one. Sand seams may be another instance of this phenomenon.

It would be of interest to determine whether thoroughly killing the steel in the mold, with say Al, would tend to eliminate sand seams. If so, this would indicate that "action in the mold" is at least as important in causing sand seams as the presence of nonmetallic material eroded from the refractories of the runner and ladle lining, because the steel is high in MnO as it leaves the furnace. In either case, however, the indicated remedies would seem to be more thorough deoxidation of the steel in the furnace and ladle, and the use of less erodible (possibly basic) refractories for lining the runners and ladle.

Flake

Flake, appearing as snow-white, circular spots in the fracture, or as radial hair-line cracks in a deep-etched cross-section, is a long familiar defect in alloy steel forgings. Its occurrence must be dependent to a considerable extent on the furnace practice, since basic electric steel is known to be particularly susceptible[39, 41] and some heats are much more susceptible to flakes than others. However, the variables in the furnace practice which increase the susceptibility have never been definitely determined. On the other hand, flake can be largely eliminated by slow-cooling after forging, and this remains the chief remedy for overcoming this defect.

The Le Creusot Works obtained a German patent (DRP 217,083) in 1908 for special retarded cooling, or reheating to below the critical temperature, to avoid flakes. It now appears rather obvious that flake is closely related to the "shatter cracks" in steel rails which are considered to form the nuclei for transverse fissures. Yet, although shatter cracks in deep-etched steel rails were revealed by Waring and Hofammann[43] as early as 1919, it is only recently that retarded cooling of steel rails has been attempted—and successfully—in overcoming shatter cracks.

Freeman and Quick[40] assumed that the temperature range during which shatter cracks form in cooling is the "secondary low ductile" range which occurs at about 900 to 1200 deg. F. (500 to 650 deg. C). It now seems, however, that the temperature range during which the damage occurs may be appreciably lower, since rails cooled in air on the hot beds until they are appreciably below the secondary low-ductile range, and cooled more slowly only thereafter, are also reported to be free of shatter cracks. This would seem to indicate that the low ductility of some rail steels in the "secondary low-ductile" region of about 1000 deg. F. is not a cause of shatter cracks. Similar results in respect to flake have been obtained by Houdremont and Korschan[41]. Based on these results and on experiments in which the addition of H to steel gave rise to flake, Bennek, Schenck, and Müller[42] have suggested that the presence of dissolved H is the governing factor in the formation of flake.

Houdremont and Korschan's results indicating that the temperature range of the formation of flake is very low, being somewhere in the region of 200 deg. C. or about 400 deg. F., are shown in Figs. 21 and 22. The compositions of the two steels used are given below; both were susceptible to flake.

Type	C, %	Si, %	Mn, %	Ni, %	Cr, %
Steel 2 Basic Electric	0.45	0.25	0.65	3.50	0.50
Steel 3 Basic Open-Hearth	1.0	0.25	0.35	0.10	1.4

For the experiments indicated in Fig. 21, the forgings were transferred to a furnace held at 900 deg. C. directly after forging, the finishing temperature also being 900 deg. C. The furnace was held 1 hr. at this temperature; the forgings were then allowed to cool with the furnace to 700 deg. C., at which time one was withdrawn and allowed to cool in air; the furnace was then allowed to cool to 500 deg. C. and another forging withdrawn and cooled in air; and similarly, as the furnace cooled down to room temperature, one forging was withdrawn at 100 deg. C. intervals and cooled in air. All of the forgings withdrawn from the furnace at the higher temperatures showed flake, but when the forgings of steel No. 2 were withdrawn below 200 deg. C., and of Steel No. 3 below 300 deg. C., they did not show flake.

For the experiments of Fig. 22 the samples were air cooled from the finishing temperature of forging down to temperatures between 480 deg. and room temperature, as indicated. They were then placed in a furnace, held at 600 deg. C., and cooled with the furnace. As shown in Fig. 22, all of the samples cooled in air, even down to 108 deg. C., and then heated to 600 deg. C., showed no flake; those air cooled to room temperature, however, and reheated in the same way showed flake. The results of Fig. 22 would seem to indicate an even lower temperature of formation of flake in this material than those of Fig. 21, but this may be attributed to a possible slight "healing" effect of the heating directly after air cooling.

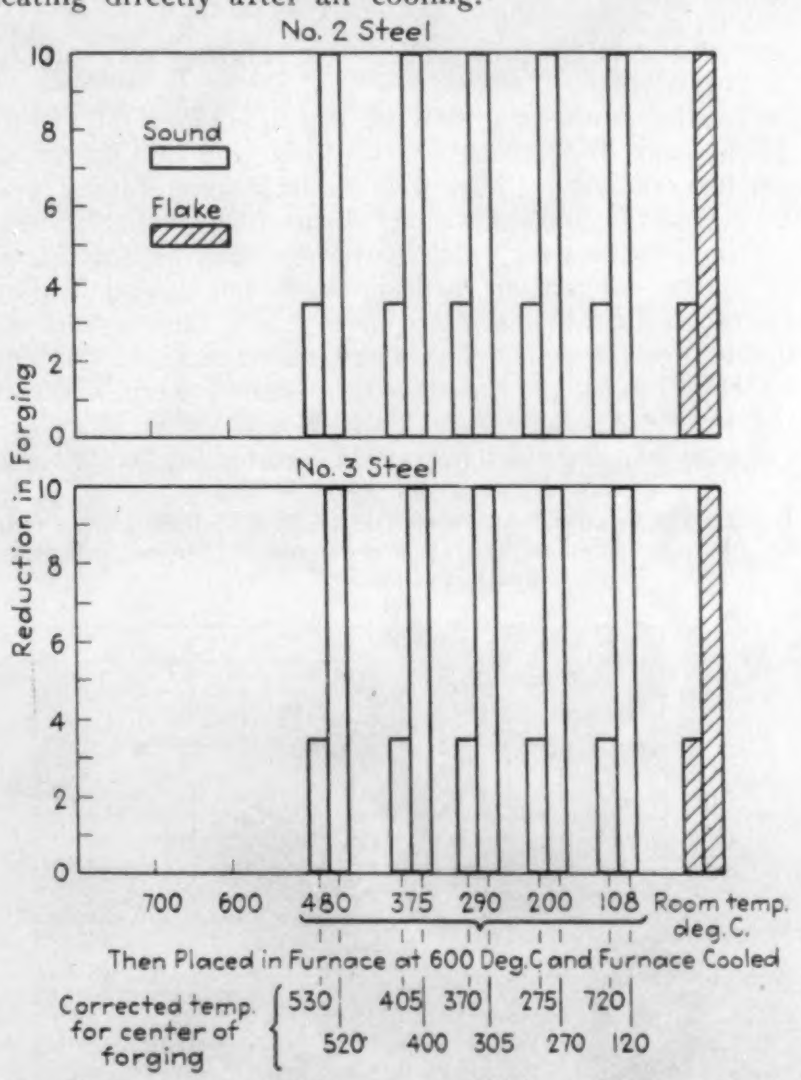


Fig. 22. Temperature of Occurrence of Flake in Forgings. Houdremont and Korschan.[41] Different forgings were air cooled from the finishing temperature to the temperatures indicated and then reheated to 600 deg. C. and furnace cooled.

Now the results, particularly of Fig. 21, are of the utmost interest, since they indicate not only that flakes occur at a low temperature but also that thermal stresses set up during cooling and stresses due to allotropic transformation probably play little or no part in the formation of flake. One would certainly not expect large thermal stresses to be set up in steel forgings, furnace cooled to 200 or 300 deg. C., even if the furnace cooling is followed by air cooling. Likewise, the allotropic transformations in these steels on furnace cooling take place at much higher tempera-

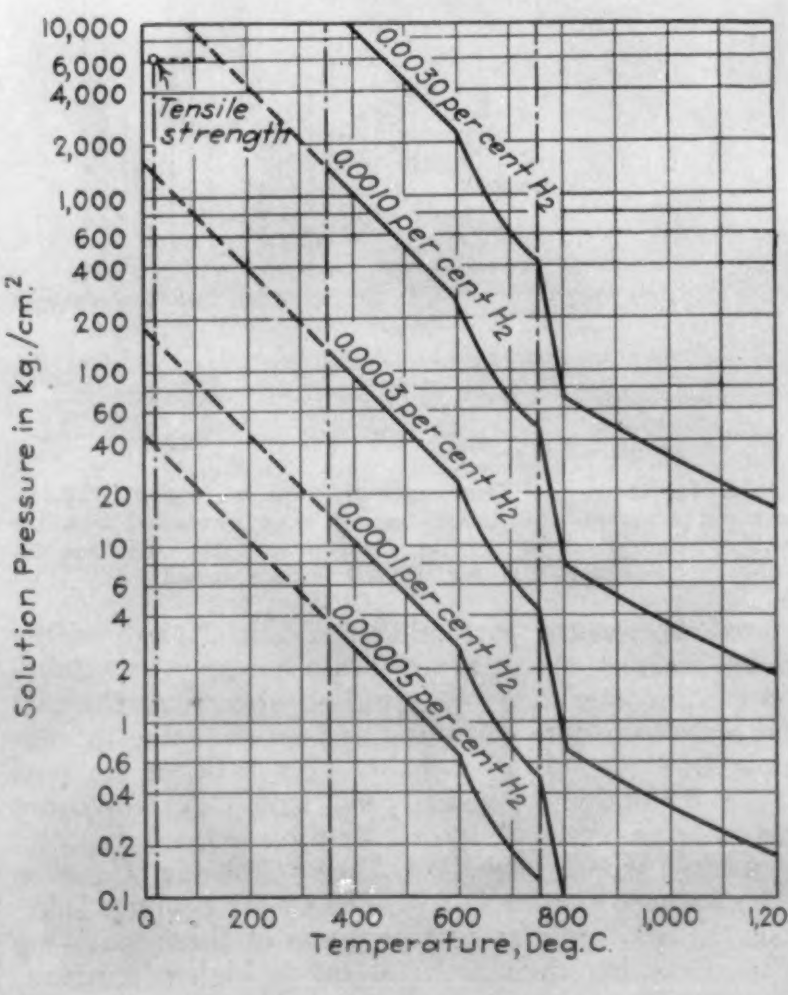
tures and would, therefore, not be expected to introduce stresses at the low temperatures at which flake apparently appears.

Solution Pressure of Dissolved Hydrogen

Bennek, Schenck, and Müller[42] have thereupon concluded that the only other likely source of stresses in steel, large enough to cause internal rupture at the temperatures in question, is the solution pressure of dissolved H.

We have already seen in Fig. 11 [Part II, June, 1935, page 163], that the solution pressure of H in steel increases rapidly with falling temperature and may, for the amounts of H ordinarily found in steel, attain a value greater than the strength of soft steel. A similar calculation by Bennek, Schenck, and Müller for a Ni-Cr alloy is given in Fig. 23. This would indicate, for the particular alloy, that, for an H content of 0.0030 per cent, the solution pressure would exceed the tensile strength (and flake would presumably occur) at 400 deg. C.; for an H content of 0.0010 per cent the strength would be exceeded (flake) at under 200 deg. C.; with the lower H contents the solution pressure would not exceed the strength even down to room temperature (and flake would not occur).

Fig. 23. The Solution Pressure of H in a 0.01 C, 3.1 Ni, 2.6 per cent Cr Alloy, as Affected by Temperature and H Content. Bennek, Schenck, and Müller.[42]



The authors were not content merely with this theoretical evidence, however, and investigated the effect of H on the susceptibility to flake of experimental 120-lb. induction furnace melts made under a $CaO-CaF_2$ slag. H was introduced into some of the melts by means of a quartz tube. Their results are given in Table III, and these seem to indicate very definitely that the addition of H caused flake. The flakes were of the usual type observed in forgings tending to be radial and to segregate toward the center. To complete the demonstration it would seem desirable to show by H analyses that commercial steels of a certain composition susceptible to flake contain more H than steels of the same composition not susceptible to flake. This the authors have not yet done, although they do state that basic electric steel, which is more susceptible to flake than acid electric steel, also contains more H.

Table III.—Susceptibility to Flake of H-Treated Induction Furnace Melts

Bennek, Schenck, and Müller[42]

C	Si	Mn	P	S	Ni	Cr	Gas Addition	Type Mold	Behavior in Pouring	Degree of Forging	Results
Composition, Per Cent											
0.22	0.42	0.63	0.075	0.073	3.64	0.87	—	Copper	Quiet	Ingots stripped and Forged Directly to One-Half Reduction	No flakes
0.18	0.35	0.58	0.076	0.048	3.67	0.85	—	Copper	Quiet		No flakes
0.16	0.15	0.57	0.081	0.082	3.78	0.88	H	Copper	Rose slightly		Flakes
0.18	0.08	0.50	0.014	0.023	3.69	0.83	H	Copper	Quiet		Flakes
0.14	0.25	0.60	0.071	0.069	3.56	0.91	—	Cast Iron, no hot top	Rose slightly		No flakes
0.29	0.27	0.58	0.010	0.010	3.72	0.91	H	Cast Iron, no hot top	Quiet		Flakes
0.14	0.17	0.57	0.076	0.069	3.73	0.84	H	Cast Iron, no hot top	Quiet		Flakes
0.14	0.26	0.60	0.083	0.054	3.75	0.89	H	Cast Iron, with hot top	Rose slightly		Flakes in head
0.22	0.31	0.57	0.071	0.070	3.73	0.86	—	Sand	Rose slightly		No flakes
0.22	0.26	0.58	0.072	0.035	3.73	0.85	H	Sand	Quiet		No flakes
0.22	0.20	0.54	0.012	0.010	3.74	0.87	H	Copper	Rose slightly	Ingots Reheated and Forged to One-Fourth Reduction	Flakes
0.28	0.15	0.55	0.010	0.010	3.74	0.88	H	Copper	Quiet		Flakes

Before making a more thorough analysis of the H theory both for flakes and shatter cracks, and indeed before building too much upon it, further confirmatory evidence should be obtained. The theory presents something very definite to work on, since the amount of H introduced into the steel may to some extent be controllable, as was discussed on pages 162 and 163, June, 1935. In basic electric steel the time between the removal of the first oxidizing slag and its replacement by the carbide slag, during which the bath is bare, would be especially favorable for H absorption, and this may account for the higher susceptibility to flake of basic electric steel.

(To be concluded)

Bibliography

[34] F. Latta, E. Killing and F. Sauerwald. "Non-Metallic Inclusions in Large Steel Forgings." *Stahl und Eisen*, Vol. 53, Mar. 30, 1933, pages 313-326. See discussion by P. Bardenheuer et al.

[35] K. von Kerpely. "Sand Seams in Locomotive Crank Shafts." *Stahl und Eisen*, Vol. 54, Nov. 8, 1934, pages 1153-1158, 1180-1186.

[36] H. D. Phillips. "Oxygen in Acid Electric Steel." *Foundry*, Vol. 61, March, 1933, pages 13-14, 50, 52.

[37] C. H. Herty, Jr., C. F. Christopher, M. W. Lightner and H. Freeman. "The Physical Chemistry of Steel Making: Deoxidation of Open-hearth Steel with Manganese-Silicon Alloys." *Cooperative Bulletin 58*. Mining & Metallurgical Investigations, Carnegie Institute of Technology. 1932, 73 pages.

[38] F. Bardenheuer. "Formation of Ghost Lines in Silicon-Killed Steel Ingots." *Stahl und Eisen*, Vol. 54, Oct. 18, 1934, pages 1073-1081.

[39] C. E. Margerum. "Facts, Not Theories, About Flakes in Gun Forgings." *Metal Progress*, Vol. 25, 1934, pages 37-40.

[40] J. R. Freeman and G. W. Quick. "Tensile Properties of Rail and Other Steels at Elevated Temperatures." *Journal of Research*, Bureau of Standards, Vol. 4, 1930, pages 549-591.

[41] E. Houdremont and H. Korschan. "Conditions for Flake Formation in Steel." *Stahl und Eisen*, Vol. 55, Mar. 14, 1935, pages 297-304.

[42] H. Bennek, H. Schenck and H. Müller. "Cause of Flake in Steel." *Stahl und Eisen*, Vol. 44, Mar. 21, 1935, pages 321-331.

[43] F. M. Waring aud K. E. Hofammann. "Deep Etching of Rails and For-ings." *Proceedings*, American Society for Testing Materials, Vol. 19, Pt. 2, pages 182-205.

Sulphur Determination by the Combustion Method

in Carbon Steels, High-Speed Steels, 18:8, etc.

By H. A. KAR

Research Chemist, The Timken Steel & Tube Co., Canton, Ohio

LACK OF ADEQUATE methods for the separation of very small amounts of sulphur from large masses of iron, chromium, nickel, molybdenum, etc., has created an analytical problem for establishing the true quantity of sulphur present in steels.

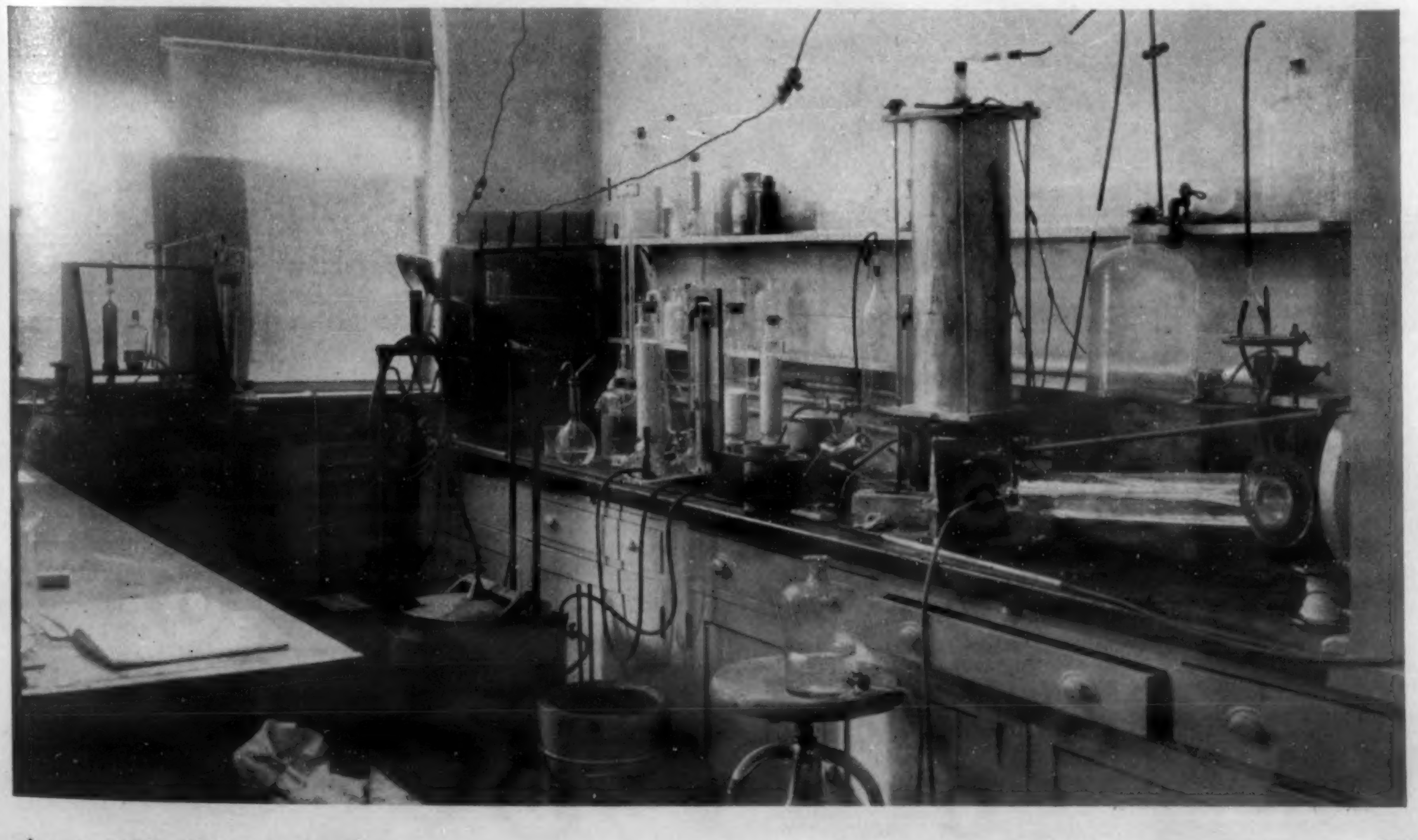
The Three Methods Usually Used

Up to the present time three methods have been used for sulphur determination: The evolution method, the hydrogen gas method, and the oxidation method. The first two methods deal with the separation of sulphur from iron and other alloying elements, and the third deals with the determination of sulphur in the presence of iron.

The evolution method calls for dissolving the steel in dilute hydrochloric acid and collecting the resultant gas (hydrogen sulphide) in an absorbent such as cadmium-ammonium-chloride. This method, though very short, does not produce accurate results because elements such as carbon, molybdenum, copper, etc., in the steel prevent the complete liberation of sulphur even in the presence of concentrated acid. This method does not function on all grades of steel, as there are many alloys insoluble in hydrochloric acid.

The hydrogen gas method calls for passing hydrogen gas over the steel in a hot tube, and collecting the resultant gas in cadmium-ammonium-chloride. This method has no particular advantage over the evolution method in producing better results, except that it works with steel upon which the evolution method does not function. The operation of this method is very dangerous.

The oxidation method calls for dissolving the steels in concentrated nitric acid and precipitating the resultant compound (sulphur trioxide) with barium chloride, after replacing the nitric acid with hydrochloric acid. This method is tedious and the results, obtained after 48 hr.'s work may not be correct. Many grades of steel do not dissolve in concentrated nitric acid, and dissolving the sample in dilute nitric acid and aqua

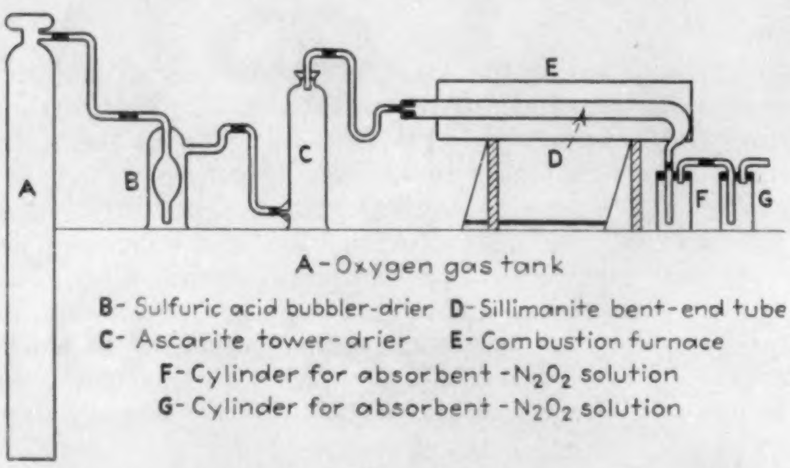


regia is not suitable for obtaining accurate results as these solvents cause loss of sulphur. Also there are some alloys which do not dissolve completely in any of these acids.

The Carbon Determination Method

Observing all these difficulties, we attempted to devise a method in the research laboratory of the Timken Steel & Tube Co. by which the sulphur could be separated properly from all grades of steel and ferroalloys. This method is similar in many respects to the carbon determination method.

The apparatus for burning the steel is composed of a carbon furnace with a sillimanite bent-end tube, a train of gas driers such as sulphuric acid and ascarite, and a cylinder containing a solution of sodium peroxide as absorbent. The drying train is connected to the front, and the cylinder of absorbent to the rear end



Schematic Reproduction of the Apparatus Used for Combustion Determination of Sulphur in Special Steels

of the tube. The sample is spread in a large clay boat, burned with oxygen, and the resultant compounds of sulphur (sulphur dioxide and sulphur trioxide) are absorbed in the sodium peroxide solution.

The Procedure

Place about one gram of sulphur-free sodium peroxide in a glass cylinder 5 in. tall and 1 in. bore, add 20 to 25 cc. distilled water and cover tightly with a two-holed sulphur-free rubber stopper. Equip one hole with a straight glass tube, one end reaching the bottom of the cylinder and the other extending one inch above the stopper. Connect this end of the glass tube to the reduced end of the combustion tube with sulphur-free rubber tubing so that both the cylinder and the end of the combustion tube are in intimate contact. Equip the other hole with a glass tube, bent at right angles, and connect this end to another cylinder containing sodium peroxide solution to check the overflow.

Spread 1 to 5 grams (according to sulphur content) of the steel in the furrow of alundum, placed in a special clay boat (5 in. by 7/8 in.), together with 1 gram of 20-mesh metallic tin. Spread a little alundum over the sample to settle the iron dust, and introduce the boat, by means of a nichrome wire, to the center of the combustion tube heated to at least 2300 deg. F. Close the tube tightly with a sulphur-free, one-hole rubber stopper connected to the oxygen and permit the gas to flow in, (same way as in carbon determination) for 1/2 hr. Shut off the oxygen gas and turn on the compressed air and allow it to flow in at a rapid rate for one hour. The oxygen gas and the air are connected to the sulphuric acid bubbler with a "Y" tube.

Disconnect the cylinders and transfer their contents to a 400 c.c. beaker. Add 0.5 gram sodium peroxide and boil for 5 min. Acidify the solution with hydrochloric acid and add 1 c.c. in excess. Boil for 10 min. filter and wash 4 or 5 times with hot water. The filtrate should not exceed 75 c.c. by volume. Add 10 to 15 c.c. of 10 per cent barium chloride solution, stir thoroughly. boil about 10 min. to coagulate the precipitate and allow to settle.

Add some ashless paper pulp to the beaker and stir thoroughly. Filter and wash with 1 per cent hot hydrochloric acid 4 or 5 times, and then with hot water about 10 times.

Ignite the paper holding the precipitate in a weighed platinum crucible at a dull red heat, cool, add one drop 1:4 sulphuric acid and a few drops of hydrofluoric acid and evaporate until fumes are given off. Heat the crucible in a dull red muffle for 5 min., cool and weigh. The gain in weight is barium sulphate.

Establish the blank on tin by the above procedure and deduct it from the total weight of barium sulphate. Multiply the remainder by 13.74 and divide by the number of grams of the sample used for the determination, to obtain the percentage of sulphur present in the steel.

This method has been tried on U. S. Bureau of Standards certified steel standard samples and the results are listed as follows:

Description	Standard Nos.	Sulphur Reported, Per Cent	Results by Comb. Method, Per Cent
Stainless steel	73	0.031	0.033
KA2 18-8 steel..........	101	0.011	0.017
High-speed Cr-W-Va.....	50	0.031	0.036
Chrome-molybdenum	72	0.021	0.020
Nickel-molybdenum	111	0.020	0.022
Chrome-vanadium	30 c	0.014	0.015
Acid O.H., 1% C... ..	35 c	0.035	0.035
Acid O.H., 1% C.......	16 b	New standard	0.046
Acid O.H., 0.8% C.....	34 a	0.026	0.027
Acid O.H., 0.4% C.....	11 c	0.026	0.028
Basic O.H., 0.2% C.....	20 c	0.033	0.032
Iron C	5 c	0.051	0.054
Ferrochrome	64	0.070	0.076
Ferromanganese	68	0.014	0.015
Ferrosilicon	58	0.010	0.011

By many trials we were convinced that there was more sulphur in Nos. 101 and 50 than was reported. KA2 and high-speed steels are difficult to handle either by oxidation or other methods.

Comments on Previous Literature

Several articles have been written in German during the last few years in regard to sulphur determination by the combustion method. In these articles the writers, whose names are given in the bibliography, have suggested the use of straight combustion tube[1], use of one gram of steel per determination[2], use of sodium hydroxide for absorbent[3] (only one writer recommends the use of hydrogen peroxide), simultaneous evolution of sulphur with carbon in 5 min.[4], iodine color or titration for finishing the determination[5], sulphur forming sulphur dioxide by the action of oxygen[6] as expressed in the general reaction given by Kassler, *Chemiker Zeitung* (1933) Vol. 5, pages 573-574:

$$S + O = SO_2$$
$$SO_2 + 2I = H_2SO_4 + 2HI$$

Experiments conducted with straight combustion tubes never proved satisfactory in regard to complete evolution of sulphur in any length of time. The bent-end tube is best fitted to this work because of its shape, which prevents the deposition of sulphur trioxide vapors.

Sulphur does not leave the combustion tube contemporaneously with carbon. By analyzing the absorbent every 15 min. we found that the minimum time for complete generation of sulphur is 1 hr., and that two different compounds of sulphur (sulphur dioxide and sulphur trioxide) were formed. The sulphur dioxide was first to generate, and there was no constant ratio between these two compounds.

Iodine in the presence of starch will titrate only sulphur dioxide absorbed in sodium hydroxide solution. Kassler takes no account for sulphur trioxide.

Absorbing both sulphur compounds in hydrogen peroxide, boiling the solution for 10 min. and then titrating with standard sodium hydroxide would serve if pure hydrogen peroxide could be obtained. All hy-

drogen peroxide sold on the market contains sulphuric acid.

The suggestion of using one gram sample per determination confines the application of this method to certain steels, while the method described in this paper is applicable to all grades of steel, using any amount of sample (from 1 to 5 grams) according to the sulphur content of the steel.

Special Notations

The use of compressed air suggested in the procedure is for economizing on oxygen gas. When combustion is complete both the oxygen gas and the air have no action other than supplying a hot blast to carry out all sulphur trioxide vapors condensed within the tube.

Clay boats have been found best for this kind of work as they do not contain sulphur, although burning them for 2 hr. with oxygen before using is advisable. As metallic tin contains the least amount of sulphur, it has been chosen as flux. For pig iron and plain carbon steels the use of flux is not necessary. Clay boats must be large enough to hold 5 grams of steel; therefore, they should be made 5 in. long and ⅞ in. wide.

There is no need for using an asbestos plug in the combustion tube. It has no particular value, and contains a considerable amount of sulphur. To prevent iron dust from running into the absorbent, the practice of spreading a little alundum over the sample and starting the combustion with a slow stream of oxygen is more beneficial than using an asbestos plug. Even if a little iron dust should run into the absorbent, it will not impair the result, as it will be filtered out later on as the method calls for.

The same sized drillings should be used in this method as is used for carbon determination. Use 5-gram samples if sulphur content is less than 0.020 per cent; 4 grams for 0.020 to 0.030 per cent; 3 grams for 0.030 to 0.040 per cent; 2 grams for 0.040 to 0.070 per cent; and 1 gram for over 0.070 per cent S.

Sodium hydroxide can be used for an absorbent, and when transferred to a beaker should be oxidized either with sodium peroxide or bromine water, and boiled.

This method can be put on a production basis by installing a 4 or 5-tube heavy duty combustion furnace and working 4 or 5 samples at one time.

Keeping the bent end of the tube at nearly the same temperature as the center is important. Therefore, the ordinary furnace should be remodeled so as to keep the hump of the tube heated to the same temperature as the center. The diagram clarifies this.

When determining sulphur on ferroalloys, and especially in the case of high-carbon alloys, use 2 or 3 grams of tin and run the gas for 2 hr.

References

[1] P. Jannasch, Praktischer Leitfaden der Gewichtsanalyze, page 188 (1904)

[2] F. Schmitz, *Stahl und Eisen*, Vol. 39, page 412 (1919).

[3] A. Vita, *Stahl und Eisen*, Vol. 40, page 933 (1920).

[4] C. Holthaus, 2, *Angewandte Chem.*, Vol. 38, page 330 (1925).

[5] A. Guerdras, *Aciers Speciaux, Metaux et Alliage*, Vol. 6, No. 66, page 75 (1931).

[6] A. Seuthe, *Stahl und Eisen*, Vol. 52, pages 445-6 (1932).

[7] Kassler, *Chemiker Zeitung* (1933), Vol. 57, pages 573-4.

Useful Applications of Aluminum Alloys

THIS IMPRESSIVE example of one of the many applications of aluminum and its alloys is the Navy and Marine Memorial at Washington, D. C., which was dedicated on Memorial Day, this year. It was erected to honor those who have and who are serving their country in all branches of sea duty.

Many other uses of this metal and its alloys include spandrels, facades, and other forms as architectural trimmings, the structure in whole or in part of airplanes, structural members for bridges, trucks, streamlined trains and so on.

Courtesy of Aluminum Co. of America

Activities of the Societies

Technical Program for Foundrymen's Convention

A technical convention that promises to be of wide interest to foundrymen in all departments of the industry will be the 39th annual meeting of the American Foundrymen's Association at Toronto, Canada, Aug. 19 to 23. Headquarters will be the Royal York Hotel. This will be the first meeting of the organization in Canada in 26 yr., or since 1909. There will be no exposition this year of foundry equipment, it being the present policy of the society to hold one every other year. The last exhibition was in Philadelphia last October.

The provisional technical program for the Toronto convention is as follows:

MONDAY, AUG. 19

COMMITTEE MEETINGS.

TUESDAY, AUG. 20

10 A. M. to 11 A. M. OPENING MEETING.
Presiding—President D. M. AVEY.
Formal Convening of 39th Annual Convention.
Address of Welcome, by L. L. ANTHES, Chairman, Toronto Foundry Committee.
Response.
President's Address.
Reports of Officers.

11 A. M. to 1 P. M. Session on CAST IRON.
Impact Resistance and Other Physical Properties of Alloy Cast Iron, by G. P. PHILLIPS, International Harvester Co., Chicago.
Heat Treatment of Cast Iron, by R. G. MCELWEE, Ecorse Foundry Co., Ecorse, Mich.
Hardening Anneal of Austenitic Iron, by G. R. DELBART, Denain, France.

11 A. M. to 1 P. M. Session on FOUNDRY SAND RESEARCH.
The Expansion and Contraction of Molding Sand Under Elevated Temperatures, by H. W. DIETERT, H. W. Dietert Co., Detroit, Mich.

REPORTS OF COMMITTEES:
Committee on Tests, on Durability, and on Fineness.

Afternoon. PLANT VISITATION.

8 P. M. Session on REFRACTORIES.
Some Uses of Insulating Refractories in Modern Foundry Practice, by C. L. NORTON, Babcock & Wilcox Co., New York, N. Y.
Malleable Furnace Refractories, by L. C. HEWITT, Laclede Christy Clay Products Co., St. Louis, Mo.
Round Table Discussion on Foundry Refractories.

8 P. M. to 9 P. M. Session No. 1 of SAND SHOP COURSE
New Sand Qualities
Chairman—NEIL I. MACARTHUR, Great Lakes Foundry Sand Co., Detroit.
Discussion Leader—GEO F. PETTINOS, George F. Pettinos, Inc., Philadelphia.

9 P. M. to 10 P. M. Session No. 1 of CAST IRON SHOP COURSE.
Cupola Melting.
Chairman—JOHN GRENNAN, University of Michigan, Ann Arbor, Mich.

WEDNESDAY, AUG. 21

9 A. M. to 11 A. M. Session on MALLEABLE CAST IRON
Endurance Tests of Malleable Iron, by E. G. MAHIN, University of Notre Dame, and J. W. HAMILTON, Bendix Products Corp., South Bend, Ind.
Notes on the Production of Cupola Malleable Iron Fittings, by F. B. RIGGAN, Stockham Pipe and Fittings Co., Birmingham, Ala.
Reports of Committee on Specifications and on Nomenclature.

9 A. M. to 11 A. M. Session on MATERIALS HANDLING AND FOUNDRY EQUIPMENT.
Mechanical Handling of Sand and Castings for Small Tonnage Plants, by E. W. BEACH, Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Mechanical Charging for Small Tonnage Foundries, by D. J. REESE, Whiting Corp., Harvey, Ill.

11 A. M. to 1 P. M. Session on CAST IRON.
Structure and Properties of Gray Cast Iron, by A. DIGIULIO and A. E. WHITE, University of Michigan, Ann Arbor, Mich.
Progress in the Production of Cast Iron for Locomotive Parts, by A. REYBURN, Canadian National Railways, Montreal, P. Q., Canada.
Piston Rings, by T. R. TWIGGER, British Piston Ring Co., Holbrook Lane, Coventry, England.

11 A. M. to 1 P. M. OPEN MEETING OF FOUNDRY COST COMMITTEE.
Chairman—SAM TOUR, Lucius Pitkin, Inc., New York, New York.

Afternoon. PLANT VISITATION.

8 P. M. to 10 P. M. Session on INDUSTRIAL HEALTH HAZARDS AND EMPLOYER RESPONSIBILITY.
Chairman—President D. M. AVEY, *The Foundry,* Cleveland.
DR. WM. J. MCCONNELL, assistant medical director and director, industrial health section, Metropolitan Life Insurance Co., New York.
DONALD L. CUMMINGS, Assistant Director, Saranac Laboratories, Saranac Lake, N. Y.

8 P. M. to 9 P. M. Session No. 2 of CAST IRON SHOP COURSE.
Chairman—FRED J. WALLS, International Nickel Co., New York.
Relation of the Air Charge to Cupola Operation, by H. V. CRAWFORD, General Electric Co., Schenectady, N. Y.
The Control of Cupola Operation, by J. GRENNAN and H. L. CAMPBELL, University of Michigan, Ann Arbor, Mich.

8 P. M. to 9 P. M. Session No. 2 of SAND SHOP COURSE.
Chairman—H. W. DIETERT, H. W. Dietert Co., Detroit.
Discussion Leader—HORACE DEANE John Deere Co., Moline, Ill.
Foundry Sand Problems Where Naturcl Sands Are Used

THURSDAY, AUG. 22

9 A. M. to 10 A. M. Session No. 3 of SAND SHOP COURSE.
Synthetic Sands.

10 A. M. to 11 A. M. Session No. 3 of CAST IRON SHOP COURSE.
Chairman—J. A. SWEENEY, Florence Pipe Foundry & Machine Co., Florence, N. J.
Adding Ferroalloys in the Cupola, by E. K. SMITH and H. C. AUFDERHAAR, Electro Metallurgical Co., Chicago.

9 A. M. to 11 A. M. Session on APPRENTICE TRAINING.
Fifteen Years of Foundry Apprenticeship at the Falk Corp., by VICTOR HYDAR, director of personnel, Falk Corp., Milwaukee, Wis.
Some Suggestions for Starting and Carrying Out a Foundry Apprenticeship System, by J. E. GOSS, employment manager, Brown & Sharpe Mfg. Co., Providence, R. I.

9 A. M. to 11 A. M. Session on NONFERROUS CASTINGS.
Third Annual Conference on Deoxidation and Degasification of Nonferrous Metals.
Report of Committee on Analysis of Defects, by H. M. ST. JOHN, Detroit Lubricator Co., Detroit.
Annual Business Meeting, Nonferrous Division.

11 A. M. to 1 P. M. Session on STEEL CASTINGS.
Contraction and Solidification of Steel for Castings. III—The Rate of Skin Formation, by C. W. BRIGGS and R. A. GEZELIUS, Naval Research Laboratory, Anacostia, D. C.
The Influence of Temperature Gradients in the Production of Steel Castings, by GEORGE BATTY, Drexel Hill, Pa. This is the 1935 Exchange paper presented before The Institute of British Foundrymen.
Reports of Committee on Impact Tests, on Chemical Classification of Steels for Castings, and on Specifications.

11 A. M. to 1 P. M. Session on SYMPOSIUM ON CENTRIFUGAL CASTING CAST IRON.
Production of Centrifugal Gray Iron Castings in Water Cooled Molds, by H. W. STUART, U. S. Pipe and Foundry Co., Burlington, N. J.
Slush Pump Piston Cores by the Centrifugal Process, by A. E. FALK, D and M Machine Co., Torrance, Cal.
Cast Iron Pipe Centrifugally Cast In Sand, by J. T. MACKENZIE, American Cast Iron Pipe Co., Birmingham, Ala.
Centrifugal Castings, by J. E. HURST, Sheepbridge Stokes Centrifugal Casting Co., Chesterfield, England.

1:15 to 3:45 P. M. ROUND TABLE LUNCHEON CONFERENCES:
(a) *Steel—Chairman,* A. W. GREGG, Farrel Cheek Steel Casting Co., Sandusky, Ohio.
(b) *Malleable Cast Iron*—Chairman, P. C. DEBRUYNE, Moline Malleable Iron Co., St. Charles, Ill.
(c) *Nonferrous*—Chairman, H. J. ROAST, Canadian Bronze Co., Ltd., Montreal, P. Q., Canada.
(d) *Cast Iron—Effects of Nitrogen and Oxygen*—Chairman, W. H. SPENCER, Sealed Power Corp., Muskegon, Mich.

4 P. M. ANNUAL BUSINESS MEETING.

7 P. M. ANNUAL DINNER.

FRIDAY, AUG. 23

9 A. M. to 11 A. M. Session on STEEL FOUNDING.
Utilization of X-Rays in the Correction of Foundry Practice and for the Proper Control of Welding of Castings, by C. M. UNDERWOOD and E. J. ASH, Naval Gun Factory, Washington.
Fabrication of Cast and Rolled Steel, by J. M. SAMPSON, General Electric Co., Schenectady, N. Y.

9 A. M. to 11 A. M. Session on CAST IRON.
Report of International Committee on Tests, by W. H. SPENCER, Sealed Power Corp., Muskegon, Mich.
Wear Resistance of White Cast Iron, by O. W. ELLIS, J. R. GORDON and G. S. FARNHAM, Ontario Research Foundation, Toronto, Canada.
Slags and Gases in Cupola Operation, by A. H. DIERKER, Ohio State University, Columbus, O.

11 A. M. to 1 P. M. Session on DUST CONTROL AND SAFETY CODES.
Dust Collection Equipment, by S. D. MOXLEY, American Cast Iron Pipe Co., Birmingham, Ala.
Methods of Dust Control, by J. D. LEITCH, Provincial Department of Health, Toronto, Can.

11 A. M. to 1 P. M. Session on NONFERROUS CASTINGS.
Founding of Magnesium Alloys, by DR. J. A. GANN and M. E. BROOKS, Dow Chemical Co., Midland, Mich.
High Strength Nonferrous Casting Alloys, by A. J. MURPHY, J. Stone & Co., Ltd., Deptford, London. (Exchange paper submitted on behalf of the Institute of British Foundrymen.)

Afternoon—CANADIAN NATIONAL EXPOSITION.

The outstanding session of general interest to all classes of foundries will be the one on "Industrial Health Hazards and Employer Responsibilities." Two of the leading authorities in this field will present the discussion. This session will be supplemented by a second one on the engineering aspects of dust collection.

A session on "Apprentice Training" will be of timely interest to the foundry executive for which two able speakers have been secured. Sessions on "Materials Handling," "Refractories" and "Sand Research" will also be of general interest. The shop operation courses and the round table luncheons will be usual features of interest and value. The papers for the regular technical sessions cover a broad range of topics.

The National Metal Congress

Outstanding leaders in the metal world will take an active part in the technical program for the Seventeenth National Metal Congress and Exposition, to be held in Chicago the week of Sept. 30. The societies participating in this year's Metal Show are the American Society for Metals, the American Welding Society, the Wire Association, and the Institute of Metals Division and the Iron and Steel Division of the American Institute of Mining and Metallurgical Engineers.

In the course of some 40 morning and afternoon sessions during the 5-day period, more than 75 papers dealing with every phase of the metal industry, will be presented. Over 100 subjects will be discussed by men whose names are synonymous with the latest developments in the science and art of metals. There will be sessions devoted strictly to research and others dealing with practical shop problems, service tests of materials, melting practice, tool steels, and alloys.

Headquarters for the Congress will be maintained at the Palmer House, where morning sessions will be conducted. Afternoon sessions will be held at the New International Amphitheatre, where the Exposition will be located.

This year's Exposition has already far outstripped the 1934 New York Show, and promises to be the largest in over five years; 25 per cent more space has been reserved at this time (July 20) than at the opening of last year's exposition. At the outset, only the main exhibit hall and one wing of the huge International Amphitheatre were laid out for display space. However, reservations have been so large that the entire space in the amphitheatre—more than 164,000 sq. ft. —is now being devoted to exhibits. More than 160 exhibitors have reserved space. All the important steel companies, most of the non-ferrous producers and makers of machines and methods used in the metal industry, will be represented at the Exposition.

"The metal industry is showing the keenest interest in years in the coming Congress and Exposition," says W. H. Eisenman, managing director of the show and national secretary of the American Society for Metals. "I fully expect that the Amphitheatre will be packed to the four walls with some of the finest displays in the history of the Exposition, and I estimate that more than 35,000 interested metal men will be in Chicago to see this show, and that at least 10,000 will be on hand during the week to hear the presentation of technical papers."

The Electrochemical Society's Fall Meeting

The 68th general meeting of The Electrochemical Society is scheduled for Oct. 10 to 12 at Washington D. C. The first scientific-technical session will be held on Thursday, Oct. 10, and will be devoted to a discussion of "High Temperature Reactions," an increasingly important topic.

J. H. Critchett, president of the society, is in charge of the program, which promises to include such authors as: Edwin F. Northrup of the Ajax Electrothermic Corp.; Marcello Pirani, high temperature expert for the Siemens & Halske Co. who will discuss extreme temperature limits and means of measuring these; H. George of the St. Gobain Laboratories, France, who will offer a paper on the high temperature reactions of the electric arc; Louis Ferrand of Paris who will present some studies in the fused electrolyte cell; T. E. Sterne of the Harvard Observatory on "Nuclear Reactions at High Temperatures," Otto Kuft of the Technische Hochschule, at Breslau, Mr. Woodell of the Carborundum Co.'s Research Laboratories; R. R. Ridgway of the Norton Co.; W. M. Cohn of Berkeley, Cal., who may discuss his sun furnace and the fusion of zirconium oxide; Wm. B. Wallis of the Pittsburgh Lectromelt Furnace Co. and V. C. Hamister of the National Carbon Co.

A session on Friday morning, Oct. 11, will be devoted to "New Batteries and Dry Cells," and on Saturday papers on electrodeposition will be read.

At the annual dinner on Oct. 10, Dr. Frank J. Tone, president of the Carborundum Co., will be formally presented with the Edward Goodrich Acheson Medal in recognition of his outstanding work with the electric furnace.

A Summer Meeting on Refractories

The Refractories Division of the American Ceramic Society will hold its summer meeting at Pennsylvania State College, State College, Pa., Sept. 20 and 21.

Following a luncheon at Centre Hills Country Club, two miles southeast of State College, on Sept. 20, there is scheduled a technical session at the club on "Trends in the Use of Refractories." In the evening there will be an outing for the Pittsburgh Clay Workers Club at Bear Meadows Clay Pits. An entertainment for the ladies is arranged for the same evening.

On Saturday, Sept. 21, golf, tennis or swimming will be indulged in at the same club or there will be the alternative selection of excursions to nearby points such as Fisherman's Paradise, Penn's Cave, Greenwood's Furnace or Shingletown Gap.

Comfortable accommodations for a maximum of 24 men are available at the Country Club at $1.00 each. Reservations at the Nittany Lion Inn at State College may be secured at $2.50 and up. Tourist accommodations are also available in State College at 75 cents each.

A special invitation is extended to the Pittsburgh Section of the Society and to Committee C-8 of the A.S.T.M. to attend this summer session. H. M. Kramer is publicity chairman, 3316 Thrush Road, Louisville, Ky.

Officers of A. S. M. E. for 1936

Nominations for officers of The American Society of Mechanical Engineers for 1936 are announced at a recent meeting of the Nominating Committee held at Cincinnati, during the semi-annual meeting. Elections will be held by letter ballot of the entire membership, closing on Sept. 24. The nominees as presented by the regular nominating committee of the society are:

President: W. L. Batt, president, SKF Industries, Inc., Philadelphia.

Vice-Presidents: A. D. Bailey, superintendent generating stations, Commonwealth Edison Co., Chicago; J. A. Hunter, professor, University of Colorado, Boulder, Col.; R. L. Sackett, dean, Pa. State College, State College, Pa.; W. A. Shoudy, Orrok, Myers & Shoudy, construction engineers, New York.

Managers: W. L. Dudley, vice-president Western Blower Co., Seattle, Wash.; W. C. Lindemann, secretary A. J. Lindemann & Hoverson Co., Milwaukee, Wis.; J. W. Parker, chief engineer, Detroit Edison Co., Detroit.

Current News Items

Potter Chosen Director of Pangborn Corp.

P. J. Potter, former 2nd vice president, has been elected a director and vice president of the Pangborn Corp., Hagerstown, Md. Mr. Potter, who will be directly responsible for engineering, sales and production, has been associated with the Pangborn organization for 20 yrs., having joined the concern in 1915 as sales representative for the Middle West and Pacific Coast territory. He was recalled to Hagerstown in 1922 to become works manager of the foundry and manufacturing plant. In 1931 he was elected a second vice president and with his co-worker, Victor F. Stine, promoted to sales director.

The promotion of Victor F. Stine to sales manager is announced. He has been with the Pangborn corporation for 23 yrs. and was recently elected second vice president. His long experience with the company has given him knowledge of all the various inter-departments. He has held 10 different titles under the Pangborn management and, in turn, has been in charge of the order, accounting, purchasing and sales department.

New Welding School in Hoboken

A new school for welding operators has been opened in Hoboken, N. J., under the supervision of William Bozman, Eastern Service Manager for the Harnischfeger Corp. of Milwaukee. Although this new school offers a complete course in all types of ferrous and non-ferrous welding, it is also maintained as a clinic where P & H-Hansen operators may bring any specific problems without charge for instruction.

Bohn Engineer Specifies Ten Piston Requirements

Pistons may have individual advantages and disadvantages but there are 10 fundamental requirements which all of them must have in order to be considered satisfactory in the light of present-day practice, states David E. Anderson, chief engineer, of the Bohn Aluminum & Brass Corp. He names these requirements in the following order:

1—Must be light in weight so as to minimize bearing loads.
2—Must be strong to avoid breakage under terrific pounding encountered from high pressures and temperatures.
3—Must resist accumulation of carbon both on the top and under side. Oil contamination is caused from loose carbon dropping into the oil.
4—The piston must fit the cylinder with proper clearance when hot and when cold.
5—It must conduct the heat of combustion from the head to the areas of heat dissipation.
6—It must withstand the pressure against the cylinder walls without deformation due to the angularity of the connecting rod and the explosion pressure.
7—It must stand the wear of the piston pins or hold the pins securely under all conditions.
8—It must carry the rings so that gas leakage in one direction and oil leakage in the other shall be at a minimum.
9—It must have a life of at least 30,000 miles, operating quietly under all conditions.
10—It must do all these things without special attention and under all sorts of conditions as regards lubrication and temperature.

Anderson states that any piston which does not live up to the above ten requirements cannot be considered satisfactory for a modern high-speed, high-output engine.

German Society Honors Elihu Thomson

On the occasion of his 82nd birthday, March 29, Dr. Elihu Thomson, holder of more than 700 patents in the United States and father of alternating-current distribution, who is generally considered one of America's greatest living scientists and inventors, was awarded the medal of honor of the Verein deutscher Ingenieure, the outstanding award of the German engineering profession. Founded in 1856, the Verein, with a membership of more than 30,000, is the oldest and largest of engineering societies in the world. Its medal of honor has previously been conferred on but five non-Germans, only one of whom was an American—the late Dr. Calvin W. Rice. "Professor" Thomson, as he is most frequently called, is the first American to be awarded any German honorary medal or degree since the organization of the new government. Presentation of the medal was made in Boston by Herr Von Tippelskirch, German consul general in that city, on the occasion of a meeting of the board of directors of the General Electric Co. of which Dr. Thomson was one of the founders. On the same day, in Berlin, more than a score of leaders in German science, industry, engineering, and statecraft gathered to do honor to the recipient of the medal.

The **Atlas Drop Forge Co.**, Lansing, Mich., has adopted a group insurance program providing more than 260 employees with life insurance ranging in amount from $1,000 to $3,000 each. The total coverage exceeds $250,000. The plan, which was announced by E. W. Goodnow, vice-president, will function under a cooperative arrangement made with the **Metropolitan Life Insurance Co.,** the underwriter, whereby the employer and employees contribute jointly to the cost.

The Timken Steel & Tube Co. announces the appointment of **S. D. Williams** as manager of tube sales with headquarters at Canton, Ohio. Mr. Williams has been connected with the steel industry since being graduated from Lehigh University as a metallurgical engineer in 1913. He started work with the Carnegie Steel Co. at Homestead, subsequently becoming superintendent of open-hearth operations for the Central Iron & Steel Co., at Harrisburg, Pa. Later he became associated with the Pittsburgh Crucible Steel Co. Midland, Pa. as chief metallurgist, and in 1926 joined The Timken Steel & Tube Co. as metallurgical sales engineer, being made assistant director of sales in 1932, which position he filled until his recent promotion.

The **Standard Fuel Engineering Co.** of Detroit, has recently appointed the **E. B. Packard Co.** of 30 Church St., New York, as representatives of their "ZERO" refractory cements and allied refractories in the New York territory.

Edward M. Adams, first vice president and general manager of sales of the **Inland Steel Co.,** Chicago, died recently at Hot Springs, Ark. Recently the company announced that **Charles R. Robinson** had been appointed to the position vacated by the death of Mr. Adams.

Westinghouse Air Conditioning Transferred to Merchandising Division

The transfer of the air conditioning department from East Pittsburgh, Pa., to Mansfield, Ohio, where it becomes a part of the merchandising division, is announced by A. E. Allen, vice president in charge of the Westinghouse Electric & Mfg. Co.'s merchandising operations. This transfer affects all sales, engineering and manufacturing activities of the air conditioning department.

The purpose of this change, according to the Westinghouse merchandising executive, is to effect a closer coordination, particularly in the design and manufacture of air conditioning equipment with the other closely allied products now within the scope of the Merchandising Division.

Announcing the transfer, Mr. Allen stated that the company's air conditioning program will be enlarged and expanded, and predicts that this business will be of great importance to the future activity of the Merchandising Division. Westinghouse will continue to distribute its air conditioning products through its present dealer channels, he continued.

The engineering and manufacturing of air conditioning products will be centered at the East Springfield, Mass., plant of the Westinghouse company. The sales headquarters will be at the Mansfield plant, the headquarters of the merchandising division. S. F. Myers will continue as manager of air conditioning sales in the refrigeration and air conditioning department, according to the announcement.

Nickel Cast Iron Data Sheets

The International Nickel Co., Inc., New York, has recently put out the latest of its nickel cast iron data sheets. This is entitled "Nickel Alloy Cast Irons and Their Special Applications in Petroleum Production Equipment." While the applications mentioned in this publication are specifically those of the petroleum industry, it will undoubtedly interest those who are anxious to obtain knowledge of the metallurgy of cast iron without studying a very technical presentation.

There are 11 pages of printed matter, well illustrated with photomicrographs and charts. There are also 12 tables of data.

Dr. Irving Langmuir, associate director of the **General Electric Research Laboratory** at Schenectady, has been elected to foreign membership in the Royal Society, England. Foreign membership, considered one of the highest honors that can be bestowed by British scientists on fellow workers in other countries, is limited to 50 persons throughout the world. Dr. Langmuir, Nobel prize winner, is one of eight Americans now foreign members of the Royal Society, and is the only American industrial scientist so honored.

W. W. Spangler has been appointed credit manager, **Westinghouse Electric Mfg. Co.,** with headquarters in East Pittsburgh. Mr. Spangler, a native of Iowa, entered the employ of the Westinghouse company in 1916, as treasury and accounting representative, Seattle, Wash., office. Since then he has held various positions including that of assistant manager, department of syndication operations; supervisor commercial research and a member of the executive staff of the vice president in charge of sales located in the New York office. Before his present appointment he was treasury manager, northwestern district, with headquarters in Chicago.

Two honorary degrees were conferred recently upon **William H. Meese,** vice president of the **Western Electric Co.** and works manager of its Point Breeze Plant in Baltimore, Md., in recognition of his professional attainments and his conspicuous civic leadership in Baltimore. The University of Michigan, Mr. Meese's alma mater, awarded him the honorary degree of Master of Engineering, while Temple University presented him with the degree of Doctor of Science.

Albert Clark Lehman, chairman of the board of the **Blaw-Knox Co.,** Pittsburgh, and founder of its original unit, died in that city on July 24, age 56. Five years after his graduation from Harvard, he organized the Blaw Collapsible Steel Centering Co., original unit of the Blaw-Knox organization. Mr. Lehman first served the company as vice-president and later as president. Recently he was elected chairman of its board.

1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

Concentration of Low Grade Iron Ore by Fire. HANS DIERGARTEN. *Metal Progress*, Vol. 27, May 1935, pages 59-60. Describes an alternate reduction and oxidation of low grade Fe ore followed by magnetic separation which yields a concentrate of 55-75% Fe from ore of 25-50% Fe. WLC (1)

Deposits, Mining and Dressing of Tin Ores (Die Lagerstätten, Gewinnung und Aufbereitung des Zinns). P. EMIRESCU. *Die Metallbörse*, Vol. 25, Feb. 9, 1935, page 179; Feb. 16, 1935, pages 210-211. The natural occurrences of Sn are reviewed. A good concentrate contains 65% Sn and a suitable one 40-45% and no Bi, As, Sb, Zn and Cu. Experiments which would permit the smelting of concentrates with only 20% Sn have reached an advanced stage. If concentrates contain more than 0.01% Bi, 0.1% As, 0.5% Sb, 0.5% Cu and 1% Zn, deductions from the price of the Sn content are made. Sn is not recovered from the occurring Cu-Sn, Sb-Sn and Bi-Sn alloys. The ore dressing methods on the Malayan Islands and in Bolivia are discussed and the difficulties encountered in the economic exploitation of German deposits at Altenberg are pointed out. Tests in German laboratories on the flotation of Sn ores are discussed critically. EF (1)

1a. Crushing, Grinding & Plant Handling

Explosive Shattering as a Possible Economical Method of Ore Preparation. JOHN GROSS & C. E. WOOD. *Progress Reports—Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 11-19. Explosive shattering by impact is favored by large charges and by low ratio of water to charge. Decreased steam consumption results in greatly increased efficiency although at the expense of some comminution. For 400 g. charges of dolomite crushed through 48 mesh, the steam costs are less than 5 cents/ton of product. The circulating load is higher than ordinarily carried in ball milling. The effect of impact is largely a scouring off of the outer portion of the larger particles. AHE (1a)

1c. Flotation

Flotation Processing of Limestone. BENJAMIN L. MILLER & CHARLES H. BEHREWOOD. *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 606, Feb. 1935, 22 pages. Describes plant treating 700 tons/24 hrs. at Valley Forge Cement Co., Pa. Impurities are quartz, micas and iron oxide. The rock is $CaCO_3$ 72.2%, Al_2O_3 5.3%, Fe_2O_3 1.7%, SiO_2 13.8%. It is ground to 85% minus 200 mesh and deslimed. Minus 200 plus 325 mesh is floated, using oleic and cresylic acids (U. S. Patent No. 1931921). The concentrate is mixed with the slime after thickening. The final mixture is $CaCO_3$ 75.8%, Al_2O_3 4.5% Fe_2O_3 1.6%, SiO_2 11.2%, while the reject is $CaCO_3$ 20.0%, Al_2O_3 17.9%, Fe_2O_3 2.7%, SiO_2 51.8%. Minerals in the reject can, if desired, be separated on shaking tables and portions remixed to form special cements. Quarrying and grinding costs were reduced, available supplies of limestone increased, and the resulting cement is better grade. JGA (1c)

Lead-zinc Ore from the Marsouins Mining Company, Ltd., Marsouins, Gaspe, Quebec. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 119-121. Ore from 2 different veins assayed, respectively, Au 0.08, 0.08 oz.; Ag 738, 11.72 oz./ton; Cu 0.20, 0.58%; Pb 12.0, 12.48%; Zn 4.60, 5.35%. The only method of concentration applicable to these ores was selective flotation. AHE (1c)

1d. Magnetic Separation

Practical Aspects of Alternating-Current Magnetic Separation. C. W. DAVIS. *Progress Reports—Metallurgical Division. 10. Mineral Physics Studies. United States Bureau of Mines, Report of Investigations* No. 3268, Feb. 1935, pages 101-107. Practically all ores containing sufficient magnetic material to develop with proper treatment a $4\pi I$ of more than 100 gausses may be separated on an a.c. machine. This includes practically all minerals that have been separated magnetically in the past except those necessitating the so-called high intensity separators. Tests on 14 ores are detailed. Commercial a.c. separators may be expected to have high capacity combined with clean separation, differential separation of the magnetic fraction, and simpler preliminary treatment than for low-intensity d.c. separation. AHE (1d)

1e. Amalgamation, Cyanidation & Leaching

Mining and Milling Methods at the Big Jim Mine, Oatman, Ariz. C. H. JOHNSON. *United States Bureau of Mines, Information Circular* No. 6824, Feb. 1935, 12 pages. The ore contains no sulphides. Au and Ag occur in a ratio of 2:1 in quartz; no other valuable metals are found. Fine grinding is necessary. Au is recovered by cyanidation; total costs are $2.437/ton. AHE (1e)

Siscoe Gold Mines, Limited. D. A. SMITH. *Canadian Mining & Metallurgical Bulletin* No. 272, Dec. 1934, pages 590-612. Amalgamation and blankets recover 94% of the Au in the ore; cyanidation of tailings adds 3%. Procedures are described. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

2a. Non-Ferrous

Reduction of Mixed Oxides (Über die Reduktion von gemischten Oxygen). K. GRASSMANN & E. J. KOHLMEYER. *Zeitschrift für anorganische und allgemeine Chemie*, Vol. 222, Mar. 30, 1935, pages 257-278. The study was undertaken to determine what alloys could be produced by reducing the oxide mixtures. The tests were carried out by heating the alloy oxides in a corundum crucible in a Mo-wound furnace for 3-4 hrs.; a temperature of 1530° C. was obtained and was held for 1 hr. The product then was quenched in water. A constant stream of H_2 was used as the reducing agent. Mixtures of the oxides of Ni, Cu, Zr, V, Ta, Nb, W, Mo, and Ce were investigated. The data for the following systems are given: Ni-V, Ni-Nb, Ni-Ta, Ni-Zr, Ni-Si, Ni-Ce, Ni-W, Ni-Mo, Cu-Mo. Data on various ternary alloys are given and the factors affecting reducing conditions are discussed. Difficultly reducible oxides such as V_2O_3, Nb_2O_3, Ta_2O_5 and CeO_2 are more easily reduced in the presence of NiO than alone at temperatures above 1380° C. when using a continuous stream of H_2 as reducing agent. The amount of metal entering the Ni base metal is not proportional to the amount of the oxides present by weight but approaches the molecular proportions of 1 mole V: 1 mole Ni, 2 moles Nb: 3 moles Ni, 1 mole Ta: 3 moles Ni, in the alloy obtained. The addition of a third easily reducible metal oxide such as WO_3 or MoO_3 improves the reducibility up to 40% W or Mo; higher contents are not reduced completely. The fineness of grinding of the oxides has no effect on the reducibility of the mixture and pre-sintering 1 hr. at 1500° C. also has no effect. The reduction of ZrO_2 and SiO_2 in binary or ternary mixtures with the foregoing metals gives less than 3% yield. When Ni metal or Cu-Ni alloy was substituted for part of the NiO in the oxide mixture the yields were reduced considerably. The oxides whose metal forms solid solutions with Ni (V, Nb, Ta, Ce) were reduced in mixtures with NiO but those forming heterogeneous structures with Ni were not reduced. With the exception of Zr the reducibility runs parallel with the H_2 solubility of the metals. WB (2a)

Nickel from New Caledonian Ores (Nickel aus neukaledonischen Nickelerzen). E. REITLER. *Die Metallbörse*, Vol. 24, Dec. 1, 1934, pages 1530-1531; Dec. 8, 1934, pages 1562-1563. Historical review of the development of New Caledonian Ni ore mining industry and detailed description of the treatment of these ores and their intermediary products in the blast furnace, roasting furnace, converter and muffle furnace. Recently 4 arc furnaces of 1,000 kw. each have been installed in the vicinity of the Ni ore deposits. It is planned to electrolyze the ferro-nickel (90% Ni) produced at present. EF (2a)

2b. Ferrous

Silica and Alumina in Iron Ores. T. L. JOSEPH & W. F. HOLBROOK. *Blast Furnace & Steel Plant,* Vol. 23, May 1935, pages 313-316. Although Al_2O_3 in blast-furnace slag decreases as ratio of SiO_2 to Al_2O_3 in ore increases, there is no fixed relation. Tests were carried out at 1500° C. on desulphurizing effect of substituting Al_2O_3 for SiO_2 in slag over a basicity range of 0.81 to 1.09, basicity being defined as ratio of $CaO + MgO$ to $SiO_2 + Al_2O_3$. Results indicate that desulphurization improved as Al_2O_3 increased up to an optimum amount which varied with basicity of slag. Content of Al_2O_3 most favorable for desulphurization was highest for most acid slag. Decrease in desulphurization when Al_2O_3 exceeded optimum amount is attributed to a large increase in viscosity. Drop in desulphurization was most pronounced in the most basic slag when Al_2O_3 was increased to 16%. Very basic slags apparently require either some thinning agent for effective desulphurization at moderate temperatures or higher temperatures. Tests made at 1442°, 1471°, 1505°, and 1558° C. on low- and high-Al_2O_3 slags having basicities of 0.8, 1, and 1.25 indicate that, except for most basic slag, substitution of Al_2O_3 for SiO_2 improved removal of S over this temperature range. For the 1.25 basic slag, more complete desulphurization was obtained with low Al_2O_3 up to 1500° C. Above this, higher-Al_2O_3 slag showed slight advantage. With low Al_2O_3, desulphurization improved over entire temperature range as basicity increased. In case of neutral slag, improvement was more gradual with increasing temperature. In other 2 cases, improvement was much greater between 1450 and 1500° C. With normal Al_2O_3 content, results with neutral slag were more satisfactory. Increase in temperature from 1475° to 1500° C. improved desulphurizing action of 1.25 basic slag markedly. This improvement is attributed to sharp reduction in viscosity between these temperatures. Apparently, larger percentages of MgO would smooth out sharp changes in desulphurization shown by basic slags. MS (2b)

Blast-furnace Fuels—Anthracite Coal. RALPH H. SWEETSER. *Metals Technology,* Feb. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 611, 8 pages. Use of anthracite, poor coke, and incorrect theories of the blast-furnace operation are reviewed. The need for research work on the problems in the hearth is stressed. "It would be worth while to determine whether the superior quality of anthracite pig iron was due to the anthracite alone or partly to the small diameter of the anthracite blast furnace." 15 references. JLG (2b)

On the Diffusion of Gases (Ueber die Diffusion von Gasen). W. ROTH. *Archiv für das Eisenhüttenwesen,* Vol. 8, Mar. 1935, pages 401-403. Simple equations for the calculation of the diffusion of gases are given. The dependence of the diffusion coefficients on the molecular weight of the gases, on the temperature, on the pressure, and on the density gradient is established. This makes possible the approximation of undetermined coefficients. The correctness of the equations was checked by experiments. Several examples are given of the use of the equations, one dealing with the rate of reduction of Fe ore. SE (2b)

3. MELTING, REFINING AND CASTING

Ford Makes Crankshafts in New Windsor Foundry. *Canadian Machinery,* Vol. 46, Apr. 1935, pages 17-18, 38. The line production of alloy steel castings for shafts is described in text and illustrated. The cast shaft is superior to former forged type, showing less than .0002" wear after 10,000 miles of car operation. The cast shaft is 10 lbs. lighter than the forging because of the use of cored crankpin journals and reduction in weight of the corresponding counterbalances. The forged shaft weighed 90 lbs. and was finished down to 66 lbs. thus taking off 24 lbs. of metal in comparison with only 9 lbs. of metal removed from the casting in finishing. The machining operations are 50 for the casting as against 62 formerly for the forging. Metal for the castings is made in 5 ton electric furnaces with 40% steel scrap and balance pig iron, back stock and alloys. The physicals are given in a table and the composition is in the range C 1.35/1.60, Mn .50/.60, Si .85/1.10, Cr .40/.50, Cu 1.5/2.0, P .10 max., S .06 max. WB (3)

Pour Through Multiple System. *Foundry,* Vol. 63, Jan. 1935, pages 26-27, 56. Describes a gating system developed by C. M. Bolich, Nickel Plate Foundry Co., Cleveland. Provides for making a combined runner and gate at the most advantageous location by a drawing operation through the ends or sides of mold and flask. This method avoids need of gating a mold at parting line. Lifting effect of molten metal is reduced, fins are eliminated and runouts are reduced. Illustrates method of making automobile valve tappets. Method is also applicable to production of a variety of comparatively small castings. VSP (3)

Use Plaster for Foundry Patterns. *Foundry,* Vol. 62, Sept. 1934, pages 12-13, 52, 54; Oct. 1934, pages 46-48, 104; Nov. 1934, pages 34-35, 70; Vol. 63, Feb. 1935, pages 30-31, 62; Mar. 1935, pages 32-33, 74. Series of articles dealing with the use of plaster as a pattern material for tablets and other castings. Takes up the method of gating a tablet, casting newel posts and similar hollow castings, method of making pattern and corebox equipment for soil pipe fittings and other castings and the strength and life of patterns and method of making certain types. VSP (3)

Plain Jolt Machine Overlooked in Jobbing Foundry Practice. J. H. EASTHAM. *Iron Age,* Vol. 135, Mar. 14, 1935, pages 10-13, 75. Illustrated description of the use of jolt molding machine in jobbing foundry. Cites several applications. Shows that costs are lowered. VSP (3)

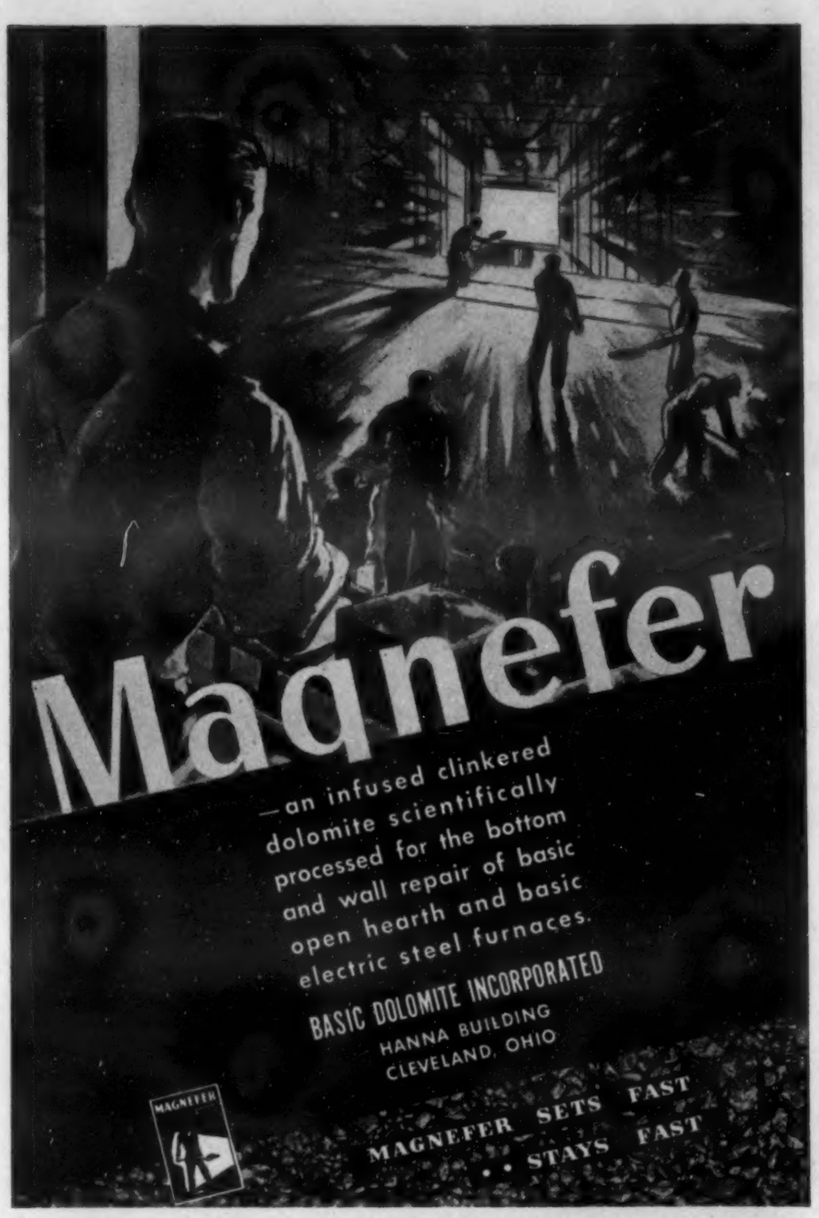
Gas Permeability of Steel Foundry Molding Materials (Gasdurchlässigkeit von Formstoffen der Stahlgiesserei). E. KNIPP. *Giesserei,* Vol. 22, Mar. 29, 1935, pages 145-148. Molding sands were tested under different conditions (tamped and dried at various temperatures) for their gas permeability. In general, permeability increases by drying, the increase being different in different sands. Addition of 4% core oil reduces permeability of sand, as does an addition of more than 4% dry binder. Spraying of the sand mold with molasses reduces permeability slightly which is restored by subsequent drying. Tamping and water content change permeability to a large extent and reduce it even to zero. Baking of the molds at 600° C. improves gas permeability. Addition of sawdust to the molding material renders the latter highly permeable. Ha (3)

3a. Non-Ferrous

Production of Sound Aluminum Castings (Zur Herstellung dichten Aluminiumgusses). EDMUND RICHARD THEWS. *Die Metallbörse,* Vol. 25, Jan. 19, 1935, pages 81-82; Jan. 26, 1935, pages 113-114; Feb. 2, 1935, page 146. Al dissolves H in the liquid but not in the solid state. Above 700° C. the solubility increases roughly by 75 cc./kg. metal 100° C. A vacuum refining process recently patented is described. In comparison with H, hydrocarbons and N play a relatively insignificant role and are only detrimental when occurring with oxide contaminations resulting from the formation of nitrides and carbides. Al scrap should be remelted separately before utilizing it for the production of new alloys. Solid scrap calls for 5-10% fluxes; chips, filings, etc. require 15%. Up to 25% of the CaF_2-NaCl mixture is utilized with heavily contaminated scrap. KCl-NaCl mixtures with 3-35% KCl are applied to scrap which has been corroded by sea water. Successful experiments with a mixture of 85 KCl, 17 CaF_2 and 2 NaCl are reported. The lower the melting point of the flux the better the cleansing action. Gas absorption due to overheating of Al cannot be remedied by lowering the casting temperature or solidification in the crucible. Casting into small ingots and remelting is necessary. Practical instructions regarding molds and casting procedure are discussed. Refining of Al is accomplished by dipping into the melt asbestos or charcoal soaked in $ZnCl_2$ or NH_4Cl. For silumin, only NH_4Cl can be employed. Passing Cl or Cl + dry N through the melt has the same effect. Patented liquid and solid purifiers are tabulated. EF (3a)

Non-ferrous Scrap Metals and Melting Practice in the Washington Navy Yard. M. W. VON BERNEWITZ. *Metal Industry,* N. Y., Vol. 33, May 1935, pages 163-164. Contains bibliography. Some statistics and descriptions of work in the foundry of the Navy Yard are given. PRK (3a)

New High-Speed Die Casting Machines. HERBERT CHASE. *Iron Age,* Vol. 135, May 9, 1935, pages 16-18. Describes high-speed equipment designed and installed by the Parker-White Metal and Machine Co., Erie, Pa., for producing Zn alloy die castings. To date only Zn alloys have been used in the machine. In order to minimize Fe pickup by alloy, machine is provided with small metal pot. Melting is done in small supplementary pots. Pots are gas fired and metal temperature is held within a range of ± 10° F. VSP (3a)



3b. Ferrous

C. H. HERTY, SECTION EDITOR

Pulling Heats Too Quickly After Pouring Results in Defective Ingots. *Steel*, Vol. 96, Apr. 22, 1935, pages 46, 48, 52. Report of meeting of Open-Hearth Committee, A.I.M.-M.E., Apr. 11-12, 1935. Among subjects discussed were ladle and teeming practice; use of Cu stools; scum on top of rimming ingots, residual metals in open-hearth steel; effect of deoxidizers other than Al on grain size; effects of all-raw limestone charge and of all-burnt lime charge on quality of steel; effect of residual Mn on rimming steel; measurement of open-hearth roof temperatures; and insulation of furnaces. MS (3b)

Some Factors in Chemical Composition of Steel Scrap. R. A. BULL. *Steel* Vol. 96, Mar. 18, 1935, pages 54, 62. Paper read before St. Louis Chapter of the Institute of Scrap Iron and Steel. Expansion of electric steel melting has served to increase greatly importance of scrap as a constituent of the cold metal charge. This expansion is due largely to increased demand for alloy steel, the production of which is the biggest factor in gradually building up content of alloying elements in commercial scrap. Presence of these elements presents a difficult problem to steel maker, particularly in case of small sized scrap sold to electric steel plants. In open-hearth practice, proportion of scrap in charge has increased. To obtain desired C content in bath, some scrap must carry a rather high percentage of C. It is evident that chemical composition of scrap used should be known; dealer should sort not only as to size but also as to composition; and dealer and melter must coöperate. MS (3b)

The Electric Arc Furnace in Steelworks and Foundry (Le Four électrique à Arc en Aciérie et en Fonderie). R. BOUTIGNY. *Usine*, Vol. 44, Apr. 4, 1935, pages 31-34. Metallurgical and electrical considerations in selecting the proper type of furnace, basic or acid process, and duplex process, are discussed. The basic process is generally employed as the bath needs only a minimum of C and Mn (2%) to protect it against oxidation by the atmosphere. In the presence of CaO and FeO, P is eliminated as phosphate of Ca if no reducing agent is present. The acid process is not much employed except for quite special steels, such as gun tubes or forged pieces. The scrap used should contain no P or S, and a high silicious slag should be used. The same method is applied in the second stage of Mn duplex process. Operating results of several furnaces are given. Ha (3b)

Calculation of Operation of a Cupola Furnace (Ancora sulla Calcolazione del Cubilotto). M. BARIGOZZI. *Industria Meccanica*, Vol. 17, Mar. 1935, pages 211-217. The question of properly calculating the thermal balance of a cupola furnace is discussed. An example of the operation of a furnace is given to show that by taking into account dimensions of furnace, radiation losses, and quality and quantity of charge, a fairly accurate calculation of the yield can be made. Ha (3b)

Nature of Flakes as Related to Methods of Steel Production. V. M. ZAMORUJEV. *Domez*, No. 1, 1935, pages 31-41. In Russian. Some authorities consider flakes caused by non-metallic inclusions in the ingots. Others attribute them to cracks caused by internal cooling stresses, either in the ingot, during mechanical treatment or in the final heat treatment. Theories are advanced connecting flake formation with blow holes, globules of CO formed in poorly deoxidized steel during rolling, shrinkage cracking of the ingots or cracking caused by mechanical deformations in working, melting during mechanical working of the interdendritic films of eutectics or with the formation of N rich films. All these theories point to the nonuniformity of the metal as the basic cause of flake formation. To get rid of them one has to conduct a heat in such a way as to eliminate as far as possible the non-metallic particles suspended in the bath, totally remove them from the ingots, suppress to the greatest possible extent the amount of segregations among the dendrites and fully prevent the formation of blowholes in the ingots. Steel can be made flake-free, not producing them under any conditions. It may be susceptible to flakes under the conditions of working or thermal treatment though not having them originally. The steel can be flaky at the very start. Steel making processes leading to flake-free steel have to be conducted under such physico-chemical conditions that the deoxidation of the metallic bath takes place gradually, naturally and without enriching the bath with non-metallic inclusions. Slag deoxidation is to be preferred to deoxidation by means of additions, which have to be made as late as possible for best results. Slags of basic open hearth furnace are not suitable for deoxidation by their nature. In order to overcome this the charge must contain high (1.25-2.00) Mn content which should not be allowed to drop under 0.30-0.35 at any period of the heat, and to have a strong boil at the latter stages of the making. It should be so active that the amount of O_2 supplied by the flame is not sufficient for carrying the reaction and the O_2 is consumed both from the slag and from the metal. After a strong boil the doors should be closed, the flame made neutral or slightly reducing and some pitch and 1 to 1.5% of the weight of the heat of calcium carbide added on the slag. When a maximum possible deoxidation is achieved Si content is brought to 0.10-0.15% by adding complex deoxidizers to the bath, the composition adjusted as desired and in 30-40 minutes the heat tapped, Al type of deoxidizers being added to the bath. No ore additions are permissible later than 1½ hrs. before tapping. Acid open hearth furnace is better for the purpose, and 3 methods can be used: mild Si reduction, not over 0.10% controlled by temperature used by slag (5-10% CaO, 50% SiO_2); partial Si reduction, 0.10-0.13%, which requires a previous strong boil with Mn content not lower than 0.30% calling for Mn content in the charge of about 1.5%; Tyjnov' process (*Vestnik Metallopromishlennosti*, No. 12. 1928, page 5) in which 0.25-0.30% Si is reduced. In the latter process the charge does not present any difference from the average, but no ore is used and the temperature is kept as high as possible soon after the melting down. Besides the usual reaction of C elimination this causes reduction of Si which reaches 0.25-0.30% with high temperature and slags containing 50-52% SiO_2. The bath is practically dead at this stage which begins the period of stabilization. It consists in lowering the temperature somewhat and keeping the bath in the furnace about 2 hours to permit the elimination of the smallest inclusions by upward settling. The process can be modified by elimination of the stabilization period, but this required a long, 2 to 4 hour, boil associated with a high original C content of the order of 2.5%. Melting in an electric furnace with a basic lining, skimming black slag and keeping the metal under a white slag does not effect a sufficient deoxidation to prepare the metal for the refining period. Si has to be introduced in the slag to deoxidize the metal. This takes place after a strong boil when Mn is kept above 0.25-0.30%. The metal must be well degasified, because refining operation is too short to produce a sufficient elimination of non-metallic inclusions. Refining under a carbide slag for about 1 to 1½ hours appears to be the best method for full preliminary deoxidation and subsequent freedom from flakes. When properly deoxidized during the first stage of making, steel may be teemed hot without any detrimental effects but the steels which are suspected to contain very small non-metallic inclusions or gases are preferably teemed cold to prevent the segregations caused by dendritic solidification. (3b)

Finishing the Heat of Steel. XXX, XXXI. J. H. HRUSKA. *Blast Furnace & Steel Plant*, Vol. 23, Mar. 1935, pages 197, 200; Apr. 1935, pages 257-260, 266. XXX. Deals with grain size in ingots and ingot core. Determination of grain sizes in a 40-ton ingot of basic open-hearth steel showed that crystal size increases gradually from bottom to top. Size of grains near surface was larger than that near axis at the same height, except close to hot top, where size of grains near axis was considerably larger. Separation of pure Fe crystals from the liquid mass appears to be the most satisfactory hypothesis for formation of core. XXXI. Deals with the chemical characteristics of rimmed ingots. Includes results of author's observations on extent of blow-holes, distribution of chemical elements through axial section, composition of gases in blow-holes, and composition of scums. In one case, total area of all types of blow-holes was 7.27% of total area of ingot section. Vacuum-fusion determination of blow-hole gases showed that CO, H_2 and N_2 occurred in the 3 types of holes, but concentration varied. In each instance cited, amount of CO was largest. Scum is mainly a silicate of Mn and Fe. MS (3b)

Comparison of High Speed Steel Made in the Induction Furnace and in the Electric-Arc Furnace (Vergleich von Schnellarbeitsstählen aus dem kernlosen Induktionsofen und aus dem Lichtbogenofen). E. HOUDREMONT, H. KALLEN & K. GEBHARD. *Stahl und Eisen*, Vol. 55, Feb. 28, 1935, pages 228-234. To determine whether induction furnace steel is any different from electric furnace steel of the same composition, 50 and 1000 kg. induction furnace melts of 18-4-1 and 14-4-2 high speed steels (some melts also having additions of Mo and Co) were compared with similar electric furnace steel. Carbide distribution appeared to be more uniform in the induction furnace steel. The hardness, resistance to tempering, and the life, were however, no higher than in similar arc furnace steel. Small variations in chemical composition had greater effects than the type of charge or melting procedure. SE (3b)

Further Notes on Defects in Steel Castings. C. HOWELL KAIN. *Foundry Trade Journal*, Vol. 52, Feb. 21, 1935, pages 139-141. Paper read before Sheffield and East Midland branch of Institute of British Foundrymen. Principal defects, cracks, pencil gates, blowholes, etc., are discussed. The presence of cold laps on the surface of the casting, particularly on inner surface or near to a heavy section on a thin section was observed when using the open sand. Different explanations of this phenomenon are suggested by the author. AIK (3b)

4. WORKING

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Direct Rolling of Brass. W. A. WOOD. *Metal Industry*, N. Y. Vol. 33, May 1935, page 162. Principle of a continuous casting and rolling process for both ferrous and non-ferrous metals is not new. The modern non-ferrous casting shop equipped with electric furnaces and "Junker" water cooled molds is most efficient and can cast slabs at a lower cost than by pouring a casting into a live mill. Foreign practice of hot rolling makes possible great economies also in cold rolling. PRK (4a)

The Rolling of Steel. H. WILLIAMS. *Journal Institution of Production Engineers*, Vol. 14, Feb. 1935, pages 49-71. The principles involved in the operation of hot rolling are outlined, with brief reference to the effects of area of contact, rate of compression, roll spring, friction, spreading, and tension. The main features of typical 2- and 3-high blooming mills and mills for rolling rounds, hexagons, angles, beams, plates, sheets, and slabs are discussed. JCC (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

Rolling-in of Boiler Tubes. F. F. FISHER & E. T. COPE. *Transactions American Society of Mechanical Engineers*, Vol. 57, May 1935, pages 145-152. A new practice is described and the factors are discussed which must be observed to avoid a predisposition to corrosion fatigue due to points of high-stress concentration. Ha (4b)

Sons of the "Village Smithy." B. K. PRICE. *Steel*, Vol. 96, May 20, 1935, pages 35-36, 38. Describes shop of Kenneth Lynch, Inc., Long Island City, N. Y., and process of forging a 16th century rapier. MS (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

Stresses and Deformations in Tube Drawing (Spannungen und Werkstofffluss beim Rohrziehen). E. SIEBEL & E. WEBER. *Stahl und Eisen*, Vol. 55, Mar. 21, 1935, pages 331-334. Experiments were made from which at least qualitative deductions could be drawn as to the stresses and deformations which may be produced during practical tube drawing. SE (4c)

Anisotropy of Rolled Materials (Über die Anisotropie gewaltzter Materialien). A. SCHIGADLO & S. SIDELNIKOW. *Physikalische Zeitschrift dēr Sowjetunion*, Vol. 5, No. 5, 1934, pages 714-721. Conclusions of the modern theory of ferromagnetism of polycrystalline materials is in excellent agreement with experimental evidence if the texture of the test piece is taken into account. The decisive influence of the texture was investigated on a cold rolled dynamo sheet on which hysteresis loops were taken at angles of 0°, 20°, 35°, 70° and 90° with respect to the direction of rolling. It is pointed out that literature statements on various properties of polycrystalline ferromagnetic materials must be accepted with scepticism unless the texture of the materials tested is clearly defined. EF (4c)

4d. Machining

H. W. GRAHAM, SECTION EDITOR

Savings in Metal by Taking Light Cuts Under Scale. *Automotive Industries*, Vol. 72, Apr. 6, 1935, page 477. Economies may be made by reducing the depth of surplus metal ordinarily provided in castings when using cemented carbide cutting tools. Such tools can be used for taking an extremely light cut just under the scale of sand castings. BWG (4d)

Micro-movie Study of Built-up Edge Shows What Happens When Metal Is Cut. *Automotive Industries*, Vol. 72, Feb. 16, 1935, pages 202-203, 214. Studies of Ernst and Martellotti as given at 1934 A.S.M.E. meeting are given an extended illustrated abstract. Behavior of materials while being cut on a milling machine were made by focussing a microscope on the area at the tool tip and taking motion pictures of the action through the microscope eyepiece. BWG (4d)

Heat and Energy Consumption in Chipping when Drilling Metals (Wärme und Zerspannungsarbeit beim Bohren von Metallen). R. POSSELT. *Berg- und Hüttenmännisches Jahrbuch*, Vol. 83, Mar. 28, 1935, pages 22-28. An analysis of the work expended in drilling different metals showed that by far the greater part of it is transformed into heat. The part actually used up for chipping increases with increasing cutting pressure. The preliminary results will be used to develop a more exact method for obtaining numerical classification of the keenness of cutting edges. Ha (4d)

Short-Cycle Malleable Iron Reduces Machining Costs. J. M. HIGHDUCHECK. *Steel*, Vol. 96, May 6, 1935, pages 51-52. Short-cycle electric furnace malleablizing process produces an Fe that machines more uniformly than malleable Fe produced by old process. Machining time per piece has been reduced and tool life increased, resulting in considerable savings. Cites several examples of reduction effected in machining costs. MS (4d)

5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

1 **Thermo-Electric Pyrometers as Applied to Workshop Practice.** G. W. Ashton. *Mechanical World & Engineering Record,* Vol. 97, Apr. 5, 1935, pages 325-326. Tool failures are mostly caused by incorrect heat treatment. Practical rules for the use and care of pyrometers are given in the article. Kz (5)

2 **Heat Treatment and Working of Light Metals (Praktiska Anmärkningar Rörande Varmebehandling och Bearbetning av Lättmetaller).** B. Adaridi. *Teknisk Tidskrift,* (Section *Bergsvetenskap*), Vol. 65, Mar. 9, 1935, pages 21-24; Apr. 13, 1935, pages 31-32. Deals mainly with French practice. Discusses heat treatment, quenching, and annealing, and emphasizes the importance of careful temperature control in these operations. Describes various methods of hand forging, hot and cold pressing, stamping, cold drawing, and rolling. Gives data on physical testing. Most of the article deals with duralumin. BHS (5)

3 **Tool Room Practice in the Central Locomotive Works, Moghalpura.** G. E. Hoare. *Journal Institute of Locomotive Engineers,* Vol. 24, Nov.-Dec. 1934, pages 826-864. Includes a description of the heat treatment of carbon steel and high speed steel tools, the use of alloy steel tipped tools, and case hardening. JCC (5)

5a. Annealing

4 **Bright Normalizing and Deoxidizing of Sheet and Strip.** R. R. La Pelle. *Iron Age,* Vol. 135, Feb. 14, 1935, pages 26-29. Describes experimental work conducted by Westinghouse Elec. & Mfg. Co. on normalizing and deoxidizing of sheets. Furnace used was roller hearth type consisting of heating chamber, followed by water jacketed cooling chamber. No rider sheets were used in order to eliminate pitting or roll marking. Controlled atmosphere used was produced by processing butane. By this method pickling is eliminated and many defects have been done away with. Gives comparative cost figures for gas fired normalizing furnace and electric controlled atmosphere normalizing furnace. VSP (5a)

5b. Hardening, Quenching & Drawing

5 **Heat Treatment of Cold-Heading Tools.** P. L. Budwitz. *American Machinist,* Vol. 79, June 5, 1935, pages 426-427. Heat treatment of steels used in severe conditions of cold-heading of wood screws to make them hard and resistant to wear and deformation is described. The steel used is of 0.95-1.05% C, less than 0.35% Mn, 0.15-0.25% Si, 0.025% S, 0.025% P, heated to 1425°-1450° F. and quenched in water. The tools are drawn according to their specific use by color oxide and hot plate method. Ha (5b)

6 **Heating, Quenching and Drawing in Automatic Furnaces.** J. B. Nealey. *Machinery,* N. Y., Vol. 41, May 1935, pages 526-528. Describes practice in heat treating rear axles of automobiles. They are heated in a double-chambered, automatically controlled furnace to 1550° F., quenched in oil and drawn at 980° F. Ha (5b)

7 **Accurate Hardening and Tempering.** E. F. Lake. *Heat Treating & Forging,* Vol. 21, May 1935, pages 219-222. Gives general instructions for carrying out these processes. Includes tables showing increase in strength of C, Ni, and Ni-Cr steels caused by hardening and effect of various drawing temperatures on physical properties. Indicates drawing temperatures for various products. MS (5b)

5c. Aging

8 **Hardening Velocity in Precipitation Hardening (Über die Aushärtungs-geschwindigkeit bei der Ausscheidungshärtung).** Erich Söhnchen. *Metallwirtschaft,* Vol. 14, Mar. 15, 1935, pages 205-208. The magnitude of precipitation hardening is a function of time and temperature. The necessary time can be reduced by addition of a third element to a binary alloy, which either shifts the solubility curve, forms a new compound, or changes the atomic structure of the solid solution. The speed of precipitation hardening is also higher in fine grained than in coarse grained alloys. Grain refinement can be obtained in cast alloys by use of chill molds instead of sand molds and in rolled alloys by a larger amount of deformation before heat treatment. Similarly cold working accelerates precipitation hardening. These effects can best be explained by the difference in the mosaic structure. The effect of a high frequency magnetic field on the precipitation hardening rate of an Al alloy was investigated. The claim for higher and faster hardening was not substantiated. 21 references. CEM (5c)

9

5e. Carburizing

10 **Note on the Carburizing of Copper Steels.** S. Epstein & C. H. Lorig. *Metals & Alloys,* Vol. 6, Apr. 1935, pages 91-92. Cu content of steel up to 3.69% does not interfere with carburizing results if specimens are machined free from scale. Scaled specimens do not carburize uniformly probably due to preferential oxidation of Fe and formation of a layer of Cu underneath the scale preventing carburization at that point. Tests indicate that such layers of Cu formed under scale do not hinder decarburization. WLC (5e)

5f. Nitriding

Local Hardening and Nitriding Cast Iron (Le Durcissement Local des Fontes et la Nitruration). Léon Guillet & Marcel Ballay. *La Fonte,* No. 15, Jan.-Feb.-Mar. 1935, pages 559-569. Localized hardening of cast iron may be obtained by: (1) heating entire casting and cooling rapidly the part to be hardened; (2) heating either with lead bath or oxy-acetylene torch the spot to be hardened, then air or water cooling; (3) hardening entire casting, reheating and slow cooling portions desired soft. The lead bath, water cooled ordinary low carbon cast iron gave a case of 550 Brinell hardness for a depth of 5 mm. Cast iron for nitriding purposes must have fine graphite in order to avoid fragile case. This condition is realized by chilling or by the use of alloys such as Cr, Al and Mo. WHS (5f)

A Fundamental Investigation on the Nitrogen Case Hardening of Steels. Seiji Nishigori. *Denki-Seiko (Electrometallurgy of Steels),* Japan, Vol. 10, Aug. 15, 1934, pages 305-358. (In Japanese); *Technology Reports Tohoku Imperial University,* Vol. 11, May 10, 1935, pages 207-265. (In English). 95 alloyed steels were nitrided using NH_3 gas at 500° C. for 25, 50 and 100 hrs., and also at 525°, 550° and 600° C. for 50 hrs. Influence of Al, Cr, Mo, Ni and C on the properties of nitrided cases of Fe were studied, that is, the changes of Vicker's hardness, weight and microstructure of specimens due to nitriding were examined. (1) The dissociation of NH_3 gas in nitriding of steel is considered to be due to the catalytic reaction of the surface of the steel. (2) Weight and hardness increase of specimens due to nitriding is the largest in the Fe-Al alloys, especially in those containing more than 1% Al. The increased hardness is probably due to the compound ϵ' which is found by X-ray analysis. Next the weight and hardness increase remarkably in the Fe-Mo and the Fe-Cr alloys. Depth of hardening is largest in the alloy containing 2% Cr. The weight increase of the Fe-Ni alloys due to nitriding was less than that of pure Fe. (3) The microstructure of the Fe-Al and the Fe-Mo alloys shows the Widmanstätten structure, while in the Fe-Cr alloys the outermost layer consists of ϵ and γ phases. The structure of these alloys became very fine with addition of a small amount of C. The max. hardness of the nitrided part of the Fe-Cr-Al alloys varies with the amount of Al, and the properties of the inner part are affected by the amount of Cr. The alloys containing no C and more than 2% Al and Cr in total disintegrate by nitriding. By the structural diagram of the Fe-Cr-N system which was proposed by the author, the structural constituents existing in the nitrided specimens and the mechanism of the hardening were explained. TS (5f)

Microstructure of Activated and Non-Activated Iron Nitrides (Untersuchung der Microstruktur der aktivierten und nichtaktivierten Eisennitride). G. L. Natanson. *Zeitschrift für Elektrochemie,* Vol. 41, May 1935, pages 284-290. X-ray investigation of the form and size of the crystallites in activated and non-activated Fe nitrides used for NH_3 catalyst. WB (5f)

Mechanism of the Thermal Decomposition of Activated and Non-Activated Iron Nitrides (Über den mechanismus des thermischen zerfalls von aktivierten und nicht aktivierten Eisennitriden). N. I. Kobosew, B. W. Jerofejew & S. I. Shichowsky. *Zeitschrift für Elektrochemie,* Vol. 41, May 1935, pages 274-284. Investigation of Fe nitrides Fe_3N, Fe_2N activated with Al_2O_3 and non-activated as used for catalyst in NH_3 synthesis in the thermal decomposition range 300°-600° C. Curves are given and calculations made for reaction velocities of decomposition. Surface chemistry mainly. WB (5f)

Determination of Nitrogen in Nitrides by the Combustion Method. Rokuro Maeda. *Tetsu-to-Hagane,* Vol. 21, Jan. 25, 1935, pages 22-26. In Japanese. By the Pregl-Dumas' combustion method which was modified by the author, M. determined the contents of N in nitrides of Fe, Si, Al, Cr, Ni, Mn, Ti, V, Zr and in their alloys previously nitrided or not. The result obtained from this method was compared with that by distillation. The N contents obtained from both methods coincided for the nitrides of Fe, Mn, Ti and Zr, while higher values were obtained from the author's method in the cases of the nitrides of Si, Al, Ni, V and W than those by distillation. This is attributed to the fact that the nitrides of the latter metals are insoluble in common acids. TS (5f)

Nitriding of Certain Metals (Sur la Nitruration de Quelques Métaux). Paul Laffitte & Pierre Grandadam. *Comptes Rendus,* Vol. 200, Mar. 18, 1935, pages 1039-1041. Variations in the electrical resistance of a wire placed first in an atmosphere of N_2 and then in an atmosphere of NH_3 were studied as a function of time and temperature. In pure N_2, the following metals did not react with the atmosphere in the temperature range studied:

Metal	*From 0° C. to*
Electrolytic Cu	900
Al 99.99%	600
Mg (sublimed in argon)	600
Zn	400
Fe 99.98%	775
Ni 99.635%	900

In NH_3, temperature of nitriding appeared as follows:

Al	*Mg*	*Fe*	*Ni*
120° C.	200	375	435

FHC (5f)

Absorption of Nitrogen During Fusion Welding of Iron and the Fe-N Diagram (Sur l'Absorption de l'Azote par Fusion du Fer dans l'Arc et le Diagramme Fer-Azote). A. Portevin & D. Seferian. *Comptes Rendus,* Vol. 199, Dec. 26, 1934, pages 1613-1615. Studies made of samples nitrided by fusion welding do not agree in all respects with the Fe-N diagram as determined by Fry. Experiment on thermomagnetic effect with Chevenard apparatus shows a slight lowering of the Curie point as the N content in Fe increases. The presence of C, Mn, Ti as impurities in Fe decreases the rate of absorption of N. FHC (5f)

6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Electric Furnaces (Elektrische Oefen, in Fortschritte des chemischen Apparatewesens) Parts 2 and 3. Edited by H. ALTERTHUM. Akademische Verlagsgesellschaft, Leipzig, Germany. Paper, 7½ x 11 inches, 317 pages. Price 28 RM per part. This is a summary and listing of German patents on electric furnaces and accessories, to appear in 6 parts. There are 3 sections with separate paging, one classifies the patents by subjects and gives a general discussion of commercial practice on those subjects, the second gives abstracts of the German patents. Some of the more important patents are given quite fully. Part 3 brings this section up through German patent No. 420,142 (1925). The third section lists British patents, classified under subjects, but gives numbers only without abstracts or even the names of patentees.

When the last 3 parts are printed, the book will be an indispensable reference for those dealing with patent applications in this field, since it will make the prior German art more readily available, and allow the metallurgist to survey that prior art for himself without having to rely so much on his patent attorney. H. W. Gillett (6) -B-

Removal of Soaking Pit Slag (Ueber Tiefofenentschlackung und ihre Anwendung). A. ROTTER. *Stahl und Eisen*, Vol. 55, Apr. 18, 1935, pages 433-441. Various designs of soaking pits are illustrated and the method of slag removal indicated. SE (6)

Investigation on Electric Resistance Laboratory Furnaces (Étude des fours électriques à résistance utilisés dans les laboratoires). C. RIGOLLET. *Journal de Physique et le Radium*, Vol. 5, June 1934, pages 262-266. An extensive study of the heat losses of laboratory resistance furnaces. Application of Fourier's theory to an investigation on the interrelation between heat losses and thickness of insulation. The theoretical derivations and practical measurements led to the development of a resistance furnace in which temperature changes linearly with time. 12 illustrations. EF (6)

Heating Problems in the Light-Metal Industry (Wärmeanlagen in der Leichtmetallindustrie). H. R. GAUTSCHI. *Aluminium*, Vol. 17, Mar. 1935, pages 131-135. Questions of economical nature in heating, melting, refining, and casting of light metals, selection of furnace type and size, salt baths and annealing furnaces are discussed on the basis of practical experiences. Ha (6)

Design and Operating Data of an Electrically Heated Pipe Annealing Furnace with Air Circulation (Aufbau und Betriebsergebnisse eines elektrisch beheizten Rohrglühofens mit Luftumwälzung). R. GRÖGER. *Elektrowärme*, Vol. 5, Mar. 1935, pages 59-62. Tubes and rods of bronze are annealed in a furnace of 5 m. length at temperatures between 650° and 800° C. with not more than ± 5° temperature fluctuation. Uniform heat treatment is tested by hardness tests; usually the ends of a tube show 92.8 Brinell and the center 97.2. The current consumption is 16.9 kw.hr./100 kg. for a charge of 500 kg. Hardness fluctuations in rods were from 64.6 to 66.2 respectively with a current consumption of 19.4 kw.hr./100 kg. Ha (6)

Some Perfections in Operation and Charging of Cupolas (Quelques Perfectionnements dans la Conduite et le Chargement des Cubilots). GROSS. *Revue de Fonderie Moderne*, Vol. 29, Apr. 10, 1935, pages 108-110. Describes an improvement in the arrangement of the furnace which facilitates handling of charge and gives more space close to the cupola. Ha (6)

Electric Furnace Operation (Aus der Praxis der Eletroöfen). O. DENTZER. *Elektrowärme*, Vol. 5, Mar. 1935, pages 49-53. Several examples are described where fuel-heated furnaces have been replaced by electric furnaces to improve the quality of the product by closer temperature and atmosphere control. Pit furnaces, box furnaces, annealing furnaces for brass parts, and galvanizing tanks are described. Electric heating of the latter eliminated entirely formation of hard Zn by preventing local overheating to more than 450° C. Ha (6)

Steel Making. JOHN DUMMELOW. *Electrician*, Vol. 113, Nov. 9, 1934, pages 605-606. High frequency and induction furnace design are considered. Connections for a high frequency furnace installation are given in diagram form. CBJ (6)

Factors Affecting the Capacity and Thermal Efficiency of Furnaces. HERBERT SOUTHERN. *Metal Treatment*, Vol. 1, Spring 1935, pages 17-20, 29. Detailed figures for the heat balance in a selected gas-fired furnace, with hearth area of 82.5 ft.^{2}, for pot annealing coiled steel strip at 600°-1000° C., are given and compared with those for theoretical gas consumption. For efficient working, the weight of charge should be as high as possible. JCC (6)

Insulation of Open Hearths Reduces Time of Heats. GILBERT SOLER & EDWARD E. CALLINAN. *Steel*, Vol. 96, Apr. 15, 1935, pages 62, 64, 66. Among advantages resulting from complete insulation of open-hearth furnaces are fuel savings of 5-15% and reduction in time of heat from tap to tap of as much as 4%. Discusses various factors which should be considered for successful insulation. These include type of insulation, furnace design, type of fuel, flame and draft control, furnace practice, and effect of insulation on properties of refractories. MS (6)

Dry Dedusting of Blast Furnace Gas. A. I. VERHOTUROV. *Iron Age*, Vol. 135, Apr. 25, 1935, pages 19-21, 86, 88. First complete description of dry dedusting appliance used with success in Russia. Concerned only with primary cleaning. Device consists of a barrel revolving in bearings and fitted with stuffing boxes. The barrel is provided with vanes. According to law of centrifugal force dust particles are forced outward by radial acceleration and thrown out of gas through wire netting. The dry dust catcher removes 60% of total dust particles mostly coarse grade. Advantages derived from this cleaner are: (1) Heat in each unit of gas is higher than in wet cleaning; (2) Greater cleanliness in plant; (3) Low operating cost; and (4) Low cost of installation. Gives tables and calculations and drawing of cleaner. VSP (6)

Brickmason and the Brick. HENRY D. TYSON. *Blast Furnace & Steel Plant*, Vol. 23, June 1935, pages 408-410. Presents observations of a practical steel-works mason. Maintains that only a good practical bricklayer makes a successful inspector. Considers 9" x 4½" x 3" brick the ideal size. Well balanced stock should have about 8% large 9-in. and 4-5% small 9-in. clay and SiO_2 brick and should include 13½" x 9" x 2½" SiO_2 brick. MS (6)

Small Acid Open Hearth Furnace Has Capacity of One Half Ton. J. TRANTIN JR. *Foundry*, Vol. 63, May 1935, pages 22, 60. Describes a small acid open-hearth furnace developed for research work on alloy steels and Fe. Greatest departure from standard open-hearth installations is in the arrangement of checker work, both as to position of checkers and direction of flow of exhaust gases. Maximum capacity of furnace is 1000 lbs. while heats of 100 lbs. may be made with success. Includes drawings of furnace. VSP (6)

Light-Weight Cellular Brick Made for Furnace Insulation. T. E. WOOD. *Iron Age*, Vol. 135, Feb. 7, 1935, pages 26-28. Describes an insulating brick of low thermal conductivity and light weight made by the Armstrong Cork and Insulating Co., Lancaster. Pulverized diatomaceous earth is mixed with ground cork and clay, molded into brick and fired. Cork is burned out, leaving additional air cells that help increase insulation. Three types of bricks are produced: nonpareil used at temp. up to 1600° F.; Armstrong's brick at temp. up to 2500° F.; and EF brick for direct exposure in furnace atmospheres, provided there is no abrasion or direct flame impingment. Crushing strength exceeds 200 lbs./in.^{2} at temp. up to 1600° F. and it will not shrink, crack, spall or fuse. VSP (6)

New Gas Cleaning System Uses Hot Washing Stage. FRED WILLE & ALBERT MOHR, JR. *Steel*, Vol. 96, May 13, 1935, pages 42-43, 56. Describes construction and principles of the Simplex system for treating blast-furnace gas and recovering the sludge. Consists of 2 stages. In the first, or hot washing, humidifying, and conditioning stage, rough cleaning is performed by 2 sets of stationary hurdles. Final cleaning in this stage is done by passing gas through a Bassler rotor. Gas leaves this stage with 0.05 grain dust per cu. ft. and 100 grains H_2O vapor at 170° F. Partial pressure of H_2O vapor is 40%. Gas passes through 2nd or condensing and cooling stage, consisting of 2 banks of static hurdles and a Bassler rotor for final cleaning and cooling. Dust is wetted by condensation of H_2O vapor. Fine cleaned gas has less than 0.015 grain dust/ft.^{3} at standard conditions and less than 0.1 grain entrained moisture. Total power requirement is less than 2 kw./1000 ft.^{3} gas per min. Total H_2O consumption is less than 22 gal./1000 ft.^{3} gas. MS (6)

Development of Electric Arc Furnaces of Large Capacity (Zur Entwicklung von Lichtbogenöfen grosser Leistungsfähigkeit). FRITZ WALTER. *Elektrowärme*, Vol. 5, Feb. 1935, pages 25-31; Mar. 1935, pages 86-90. The utilization of the strongly concentrated energy of the electric arc by radiation and by direct heating of masses to be melted and the arrangements of the furnaces to obtain an economical performance are explained. The calculation and proper distribution of conductors, mechanical and chemical actions, advantages and disadvantages of single phase and 3-phase furnaces, and points for designing furnaces of over 5000 kw. capacity are discussed. Ha (6)

Melts Metals with Natural Gas. PAT DWYER. *Foundry*, Vol. 63, May 1935, pages 24-26, 64. Describes the methods and equipment used at the Coraopolis plant of the Homestead Valve Co. Melting equipment includes tilting type open flame and crucible furnaces, and a stationary crucible furnace for non-ferrous metals. Gas is the fuel in all 3 furnaces. Analysis of Fe for valves consists of Si 1.36-1.55%, Mn 0.48-0.60% and total C 3.05%. A Ni bronze made by the company and used in castings for tanks and other utensils consists of Ni 31%, Zn 10%, Sn 2%, Pb 3% and Cu 54%. For marine use the analysis is Cu 46%, Sn 4%, Pb 6%, Zn 6% and remainder a 50-50 mixture of Cu and Ni. VSP (6)

Electric Melting of Iron and Brass. E. E. SCOFIELD. *Electrical West*, Vol. 74, June 1935, pages 97-98. Report of Industrial Power Committee, Commercial and Industrial Sales Bureau, Business Development Section, Northwest Electric Light and Power Association. Brief sketch of use of electrical melting equipment in gray-Fe and brass foundries. MS (6)

Heating of Furnaces (Le Chauffage des Fours). GUILLON. *Usine*, Vol. 44, May 2, 1935, page 31. Generation of heat in the furnace and transmission of the heat to the material to be heated are discussed as dependent on construction, type of fuel and material. Ha (6)

Survey of Patents on Metallic Insulation. PHILIP GOLDBERG. *Refrigerating Engineering*, Vol. 28, Oct. 1934, pages 195-196, 210. Brief abstracts of 25 U. S., 17 British and 4 French patents concerned with Al and other metallic materials where the metal functions as a radiant heat insulating medium. VVK (6)

How to Obtain Large Industrial Heating Load. G. ALVIN HOWARTH. *Electrical West*, Vol. 74, June 1935, pages 96-97. Report of Industrial Power Committee, Commercial and Industrial Sales Bureau, Business Development Section, Northwest Electric Light and Power Association. Using annealing furnaces for steel as illustration, discusses problems electric heating salesman must consider. Includes cost analysis. MS (6)

Heat Treating by Forced Convection. J. R. MORRISON. *Industrial Heating*, Vol. 2, May 1935, pages 245-246. The better way of raising the temperature of material by forced convection rather than by conduction or radiation is pointed out; the lower the temperature drop of the air through the furnace the more uniform will be the furnace temperature. The higher the air velocity through the furnace the faster the heat is transferred to the material. A low temperature drop means better maintenance of the furnace. Furnaces between 400° and 1200° F. have been built on this principle. Ha (6)

P. B. SILLIMANITE RAMMING MIX

is being used to advantage in

Iron Melting Furnaces—Complete linings in rocking type, indirect arc electric furnaces. Roofs and side walls in small direct arc electric furnaces. Crucible furnaces. Brackelsberg furnaces. Barrel type furnaces.

Brass Melting Furnaces—Complete linings in indirect arc electric furnaces. Crucible furnaces. Oil and gas-fired non-crucible or open-flame furnaces.

Glass Furnaces—Burner Blocks. Port bottoms. Expansion joints. Pot furnace benches. Repairing cracks in generator walls. Leveling floors when repairing.

Miscellaneous—Oil and gas burner tunnels. Boiler furnace repairs. Fire door linings. Replacing special shapes. Forging and heat-treating furnaces. Complete construction of small furnaces.

P. B. Sillimanite Ramming Mix is produced in three grades, labeled S B F 15, No. 10 and No. 10-S, each of which weighs approximately 140-lb./cu. ft. when installed. S B F 15 is recommended for furnace linings, roofs, etc., 3½ inches or over.

TAYLOR PB SILLIMANITE

All P. B. Sillimanite made by The Chas. Taylor Sons Company bears this trademark

For your own satisfaction, check up on P. B. Sillimanite Ramming Mix. You'll be glad you learned of its possibilities.

THE CHAS. TAYLOR SONS CO.

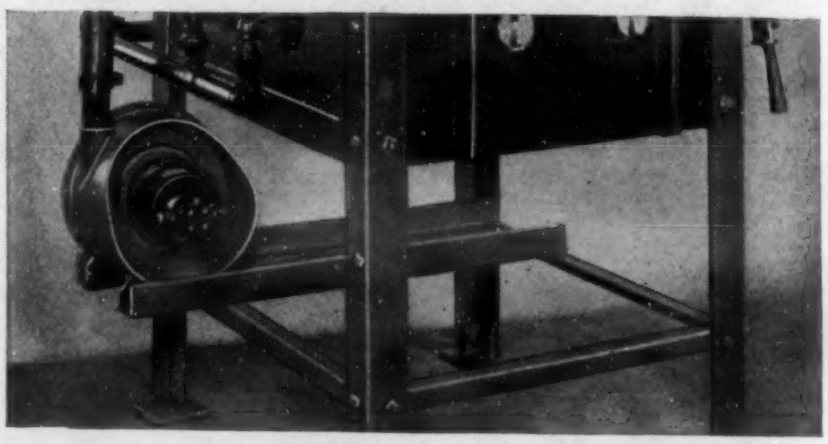
CINCINNATI, OHIO

Minimize refractory maintenance with Johns-Manville REFRACTORY CEMENTS

Write for BROCHURE RC-6A

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville
22 East 40th Street, New York City



The "Midget"—THAT BECAME A MASTER OF FURNACE AIR SUPPLY

Furnace and oven manufacturers are finding many new ways to simplify the air supply by using the new and smaller types of Spencer Turbo-Compressors.

The "Midget" Turbo shown above, for instance, provides the exact pressure and volume required for one furnace. It is direct connected, requiring little piping and the air line losses are negligible. There are no gears, no belts, and only two bearings to lubricate.

Individual air supply is also practical with the new low-cost Spencer Single-stage Turbos in sizes from ½ to 20 HP., and Spencer Multi-stage Turbos cover the range for individual or multiple service up to capacities of 300 HP.

Gas-tight and special turbos are supplied for use where acid fumes or poisonous explosive gases are handled.

SPENCER TURBO-COMPRESSORS
MIDGET • SINGLE-STAGE • MULTI-STAGE
35 to 20,000 cu. ft. • ½ to 300 HP. • 8 oz. to 5 lbs.

THE SPENCER TURBINE COMPANY, HARTFORD, CONN.

S-18

7. JOINING

7a. Soldering & Brazing

Fluxes for Soldering Iron and Non-ferrous Metals (Flussmittel zum Löten von Eisen und Nicht-Eisenmetallen). *Die Metallbörse*, Vol. 25, Jan. 5, 1935, pages 18-19; Jan. 12, 1935, pages 50-51. The former conception that the adhesion of a solder represents the paramount criterion for the strength of a soldered joint cannot be upheld. Organic contaminations at the surface are charred by the blowpipe and not eliminated by the flux. Washing with benzene is indispensable. There is no universally applicable flux. For soldering stainless steel, a borax paste which contains 25-75% boric acid is utilized. It has been noticed that the soldered joints on galvanized Fe rapidly deteriorate if soldering fluids containing free acids were employed. This is particularly pronounced with solders high in Sn. Recipe: an excess of Zn is added to 750 cc. conc. HCl + 250 cc. H_2O. When the reaction has come to an end, a solution of 50 g. NH_4Cl in 170 cc. H_2O is stirred into the $ZnCl_2$ solution. This soldering fluid is greatly improved if a solution of 30 g. $SnCl_2$ in 170 cc. H_2O is added. $ZnCl_2$ solder pastes are prepared with the aid of potato starch. Mixing with tallow, olive oil or colophony did not yield good results for brazing electrical members. A mixture of 4 pts. alcohol, 3 glycerine, 5 $ZnCl_2$ is recommended. Recipes for Al sheets: (1) 2 pts. resin, 2 ox tallow, 1 $ZnCl_2$; (2) 50 parts olive oil, 40 tallow, 25 colophony powder and 12.5 pts. saturated NH_4Cl solution. For soldering Sn: 1 part of colophony powder, 2 tallow, 2 olive oil, 2 NH_4Cl solution. Brazing of pure Al is favored in Germany but welding predominates abroad. The soldered joint is protected by a varnish or lacquer coating. The advantages of hard soldering Al are: low soldering temperature, no warping, simpler and faster joining method without skilled labor. If borax pastes are utilized on Al, blisters occur if the borax contains water of crystallisation. EF (7a)

Novel Combination Furnace and Feeding Table. *Compressed Air Magazine*, Vol. 40, Feb. 1935, page 4658. Describes an arrangement designed for speeding up the work of brazing Cu coils to steel cans. A circular furnace is suspended from the ceiling and is provided with an opening at the bottom. It is sealed by a platform on which the can rests and which is automatically operated by compressed air. The furnace operating at 1700° F. is claimed to retain its heat owing to its inverted position. The new equipment doubled the number of cans that could be brazed. WH (7a)

7b. Welding & Cutting

C. A. McCUNE, SECTION EDITOR

Overstressing in Welded Joints (Ueberanstrengungen in Schweissverbindungen). H. Buchholz. *Autogene Metallbearbeitung*, Vol. 28, Mar. 15, 1935, pages 82-89. Fusion welding causes interior stresses in the seam; apart from these there are the exterior stresses to which the structure is subjected in service. Welded seams should be avoided at places of local overstresses. If this is not possible the welding rod should at least possess tensile and elongation properties similar to the material. Interior stresses are reduced or counteracted by overstresses due to additional stresses and are not injurious if the properties of pencil and material are similar. Overstresses can lead to cracks in harder and more brittle material, especially if notch effects are present. The interior stresses become lower with wider heating zone and the exterior stresses become greater but are not dangerous. Welding with a wide heating zone always offers advantages as it reduces interior stresses and improves tensile properties. The danger of warping in this method can be obviated by rigid clamping. Many examples are shown. 17 references. Ha (7b)

Physical Properties of Fusion-Welded Joints, As Produced by Manufacturers of Class I Pressure Vessels. R. K. Hopkins. *Journal American Welding Society*, Vol. 14, Mar. 1935, pages 4-7. The physical tests to be met by makers of Class I unfired pressure vessel Boiler Code are discussed. The data collected from various fabricators are shown in curve of averages for stress vs. strain and a table of impact values for welded straight C steel. A chart of typical microstructures of weld, and adjacent metal is shown. WR (7b)

Cold Storage Room Piping Fabricated by Bronze Welding. T. F. Hooker. *Heating, Piping & Air Conditioning*, Vol. 7, Apr. 1935, pages 198-199. Joining of galvanized iron piping for use in cooling coils in $CaCl_2$ brine had to be made with low melting weld material in order to prevent burning off the galvanized coat. The other problems were the possibility of galvanic action due to contact of the dissimilar metals, the mechanical strength of the joint and the speed of fabrication. The installation is satisfactory in all respects and superior to steel-welded galvanized pipe. Corrosion test results and the completed coil are shown in photos. WB (7b)

Electric Welding Under Water (Het electrisch lasschen onder water). *Polytechnisch Weekblad*, Vol. 28, Nov. 29, 1934, pages 764-765. Two tables collect data on physical properties of specimens electrically welded under water and submitted to tensile and bending tests as reported by Hibshman, Jensen & Harvey before the American Welding Society. WH (7b)

Contribution to the Knowledge of the Welding of Bells (Beitrag zur Kenntnis der Glockenschweissung). Leo Knez. *Autogen Schweisser*, Vol. 8, Jan. 1935, pages 1-8. The technique employed in repairing bells by means of the acetylene welding process varies according to the location of the damaged parts and is discussed in detail. Composition of welding rods, prepared in each case for the cracked bell, is dealt with. Parts of a bell that have been in use for a certain length of time are workhardened. To insure a successful welding the whole bell has to be heated to 400° C. Precautions which have to be taken in this operation are discussed. Kz (7b)

Developments in Machines and Methods of Electric Welding (Progrès Réalisés dans le Matériel et les Méthodes de Soudure Electrique). *La Technique Moderne,* Vol. 27, Mar. 15, 1935, pages 219-220. Today all kinds of metal electrodes are available which make possible welds having a strength ranging from 30 to 65 kg./mm.². It is also possible to get electrodes for semi-corrosion resisting Cu steels, Ni-Cr and Mn austenitic steels. Describes some interesting welded constructions. FR (7b)

An Important Welding Development. *Synthetic & Applied Finishes,* Vol. 5, Jan. 1935, page 254. Note on an electrical process for welding Al castings recently developed by Parimar, Ltd., London. EF (7b)

L. C. C. Regulations for Welded Structures. *Structural Engineer,* Vol. 12, Dec. 1934, page 489. The new London Country Council Regulations are presented. The specifications do not favor any form of construction or process of welding in use. WH (7b)

Heavy Steel Plates Used in All-Welded 20-Foot Penstocks for Norris Dam. *Steel,* Vol. 96, Mar. 18, 1935, pages 40, 68. Sections of penstock were fabricated by the "electronic tornado" system of automatic welding. After X-ray inspection and repair of all defects disclosed, welded joints were stress relieved electrically. Sections were joined together in place by manual shielded arc welding. MS (7b)

Large-Diameter Arc Welded Pipe Used in Owyhee River Siphon Projects. *Steel,* Vol. 96, Feb. 18, 1935, pages 49-50. Describes field assembly. MS (7b)

Arc Welding Electrode Suitable for Making and Salvaging Cutting Tools. *Steel,* Vol. 96, Apr. 29, 1935, pages 32, 34. See *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 85. MS (7b)

New Automatic Welding Process Uses Heavily Coated Woven Welding Wire. *Steel,* Vol. 96, Mar. 18, 1935, page 58. See *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 173. MS (7b)

Bibliography on Use of Welding in Manufacture and Repair of Boilers and Pressure Vessels (Bibliographie sur l'Emploi de la Soudure dans la Construction et la Réparation des Chaudières et Réservoirs à Pression). *Revue de la Soudure Autogène,* Vol. 27, Mar. 1935, pages 12-15. Bibliography is classified as follows: (1) Specifications. (2) General books. (3) Miscellaneous articles. FR (7b)

Light Tube Constructions (Constructions tubulaires légères). *Revue de la Soudure Autogène,* Vol. 27, Mar. 1935, page 10. Typical applications in aircraft building and other industries are given and difficulties of manufacture are discussed. FR (7b)

Bronze Propellers Welded. *Journal of Commerce, Shipbuilding & Engineering Edition,* Dec. 6, 1934, page 2. A brief note describing the repair of two 14 ton bronze propellers, which were badly eroded and pitted and in one case fractured, which were are welded successfully after removing the eroded metal using special manganese bronze metal core electrodes. JWD (7b)

Electricity for Testing Welded Joints. *Journal of Commerce, Shipbuilding & Engineering Edition,* Jan. 17, 1935, page 1. The testing of welded joints by means of arcronograph records, which show variations in the current and voltage during deposition of the electrode is discussed. By the inspection of such records taken continuously during the carrying out of welding work, it is possible to reach definite conclusions as to the soundness or otherwise of the weld and to maintain a close and intimate control of welding. JWD (7b)

Code for Fusion Welding and Gas Cutting in Building Construction. Code I, Part A, Structural Steel Edition of 1934. *Journal American Welding Society,* Vol. 14, Mar. 1935, page 33, special section. The subjects are general application, definitions, materials, permissible unit stresses, design, workmanship, erection, gas cutting and four appendices showing application. WB (7b)

Weldability of Various Steels (Über die Schweissbarkeit der einzelnen Stahlsorten). *Der Autogen Schweisser,* Vol. 8, Mar. 1935, pages 27-30. Deals with the influence of the components of steels on the welding characteristics. Compositions of welding rods which showed good results in the welding of C, rust resisting, Mn, austenitic Mn, Cr-Mo, and austenitic Cr-Ni steels are discussed. Kz (7b)

Flame-Cutting and Beveling Pipe by Machine. *American Gas Journal,* Vol. 142, Feb. 1935, pages 26-28. Flame-cutting and beveling of pipe by machine is done efficiently and economically. CBJ (7b)

Production of Refrigerator Parts Is Speeded by Resistance Welding. A. E. Hackett. *Steel,* Vol. 96, May 6, 1935, pages 34-37; May 20, 1935, pages 30-33. Describes fabrication of electric refrigerator parts in the plants of the Kelvinator Corp., with particular stress on application of electric resistance welding. This method has replaced brazing and arc and gas welding. MS (7b)

Some Aspects of Metallic Arc Welding. Herbert Harris. *Iron & Coal Trades Review,* Vol. 130, May 3, 1935, pages 769-770. The effect of O, N and H on weld metal is discussed and the action of coated electrodes to prevent harmful gas inclusions explained. Ha (7b)

The Welding of Special Steels. W. H. Hatfield. *Iron & Coal Trades Review,* Vol. 130, May 10, 1935, pages 810-811. It is emphasized that each type of steel brings its own problem and demands careful consideration of the metallurgical and practical procedures which are discussed more fully for Ni and Cr steels, austenitic steels and some special Cr-Al, Mo and W steels. Ha (7b)

Metal Burial Vaults Are Flash Welded. F. L. Prentiss. *Iron Age,* Vol. 135, Mar. 21, 1935, pages 18-22. Use of large resistance welding machine by the Galion Metallic Vault Co. in making burial vaults is described. Marked changes in design and manufacture were made by introduction of flash welding. Vaults are made of 12-gage sheet steel. Armco ingot Fe is used in manufacture of more expensive models. Considers methods of finishing. VSP (7b)

Arc Welding for Bridge Construction. LaMotte Grover. *Civil Engineering,* Vol. 4, July 1934, pages 360-364. Domestic and international progress in the art is reviewed and means of securing maximum safety and economy are discussed. 8 illustrations. EF (7b)

Electric Welding in the Enamel Industry. P. W. Fassler. *Enamelist,* Vol. 12, Feb. 1935, pages 5-6, 39. The quality of the enamelled surface and its durability are improved by a smooth metal surface. This is obtained by welding rather than other joining methods for the different parts. Ha (7b)

Massive Machine Parts Made of Welded Rolled Steel. Rogers A. Fiske. *Iron Age,* Vol. 135, Apr. 18, 1935, pages 19, 96. Discusses the welding of castings to rolled steel members by the electric arc welding process at plants of Danly Machine Specialities, Inc., Chicago and A. O. Smith Corp'n., Milwaukee. Normalizing is important because it relieves stresses resulting from welding and removes distortion and thereby brings it to form and dimensions that are fully consistent with subsequent operations. VSP (7b)

Welding of Wrought Iron. J. E. Fletcher. *Iron & Coal Trades Review,* Vol. 130, May 3, 1935, pages 768-769. The welding qualities of wrought iron are discussed as principally depending on the puddling process in making the iron. Results of tests with welds of differently treated wrought iron are given in tables. The mechanical properties of the welds are in general little different from rolled bars. Ha (7b)

All-welded Penstock for the Norris Dam. A. F. Davis. *Metallurgia,* Vol. 11, Apr. 1935, page 150. Describes steel penstocks, which were 20 ft. in diameter and from 1⅛" to 1⅜" thick. Semicylindrical sections were welded together at the dam site. JLG (7b)

Various Applications of Torches as Seen in Rome (Les Applications Diverses du Chalumeau vues à Rome). L. de Jessey. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 6, Jan.-Feb. 1935, pages 1609-1629. Lecture before the French Welders' Society. Lecture is based on papers read in Rome (International Welding Congress). FR (7b)

Modern Welding. P. R. Dunn. *Electrical Review,* Vol. 116, May 10, 1935, page 661. Reviews the different resistance processes. MS (7b)

Tubular Members in Welded Steel Structures. O. Bondy & H. Gottfeldt. *Engineering,* Vol. 139, Apr. 5, 1935, pages 355-356; Apr. 19, 1935, pages 405-406. Development of joining tubes by welding has made them a definite competitor with rolled sections in structural work. Basing of cross-section on minimum thicknesses does not give a fair comparison for tubular as is the case with bars. Present day practice permits tubes to be made of any thickness. Oxidation is reduced by at least 50% with tubular construction as the interior is not subject to atmospheric influences. VSP (7b)

Alternating Current Welding. W. M. B. Brady. *Welding Engineer,* Vol. 20, Apr. 1935, pages 22-23. The inherent characteristics of a.c. welding are: no magnetic blow, high welding speed, lack of slag inclusions and porosity, good penetration, small spatter losses, high electrode efficiency, low welding cost per ft. of weld, and uniform weld. The advantages for pressure vessels and heavy plate welding are explained and equipment is described. Ha (7b)

Buckle Plate Design of Tanker Bulkhead Reduces Total Weight and Number of Parts. *Iron Age,* Vol. 135, June 6, 1935, pages 21-23. **Welded Steel Plate Bulkhead for Oil Tankers Performs Favorably in Tests.** *Steel,* Vol. 96, May 27, 1935, page 64. Describes an interesting departure in design of bulkheads with the testing of a scale model by Lukeweld division of Lukens Steel Co., Coatesville, Pa. Saving in wt. as compared with conventional riveted bulkhead in tanker 66 ft. beam and 38 ft. molded depth, is about 25,000 lbs. It is composed of a series of press-formed plates integrated by welding. The model was of 0.20% C steel, 3/16" thick with a yield point of about 41,000 lbs./in.^{2} and an ultimate strength of about 68,000 lbs. MS+VSP (7b)

Present-Day Practice and Problems of Welding in the Engineering Industries. *Iron & Coal Trades Review,* Vol. 130, May 17, 1935, pages 846-847. Summary of papers before the symposium on welding organized by the Iron & Steel Institute. Questions of temperature control during cooling, formation of cracks, welding in constructional work, warping and special advantages of welding are discussed. Ha (7b)

Clean Welds are Good Welds. E. W. P. Smith. *American Machinist,* Vol. 79, May 22, 1935, pages 388-389.- Attention is called to proper and effective cleaning tools to be used before and after application of the fused metal in order to obtain a fully satisfactory weld. Ha (7b)

Mechanical Properties of Spot Welds (Contribution à l'etude des Propriétés Mécaniques des Soudures Electriques par Points). E. J. L. Dussourd. *Aciers Spéciaux, Métaux et Alliages,* Vol. 9, Nov. 1934, pages 612-626. See "Contribution to the Study of Mechanical Properties of Electrical Spot Welds," *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 150. GTM (7b)

Welding under Difficulties at Coulee Dam. Henry W. Young. *Welding Engineer,* Vol. 20, May 1935, pages 22-23. Describes conditions and outfits used on the Columbia River dam. Ha (7b)

Flame Cutting Curved Plates For Boulder Dam Penstocks. W. S. Walker. *Iron Age,* Vol. 135, May 2, 1935, pages 16-21. From a paper read before the Cleveland section of the American Welding Society. Gives details of the work as well as the equipment developed. These outlets are made up from a number of plates which after being formed are trimmed and welded. Special flame cutting machine arranged to guide the torch over irregularly curved plates and give end edge a slight bevel was used. VSP (7b)

Miscellaneous Uses of Oxyacetylene Torch on Track Work. Chas. Wiss. *Welding Engineer,* Vol. 20, May 1935, pages 19-20. Economies possible in use of oxyacetylene welding in cutting, welding and building-up of rails are discussed. Ha (7b)

Metallurgical Effects Produced in Steel by Fusion Welding. A. B. KINZEL. *Metals Technology*, Jan. 1935, *American Institute Mining & Metallurgical Engineers Technical Publication* No. 597, 15 pages. Oxyacetylene welds were made in plates of C steel ½" thick. The plate was of high-strength firebox quality and contained 0.24% C. Thermocouples in the plate at different distances from the weld were used to obtain the maximum temperatures reached in the plate. The structure and mechanical properties of the steel at different distances from the weld were determined. The heat of the welding produced no noteworthy metallographic effect except in the zone immediately adjacent to the scarf. In this zone the ductility is decreased but the strength increased. The zone can be eliminated by local normalizing. The minimum strength is in the zone that is heated to the maximum subcritical temperature. The material was tested for strain aging and was found to age appreciably. Steep temperature gradients may do permanent damage to welded steel, but these can be avoided to some extent by proper design. JLG (7b)

Fusion Welding at the XIVth French Agricultural Show (La Soudure Autogène au Salon de la Machine Agricole). P. MODRO. *Revue de la Soudure Autogène*, Vol. 27, Mar. 1935, pages 6-8. Reviews typical new applications of welding process in manufacture of machines shown. FR (7b)

Electric Arc Welding in General Engineering. J. ORR. *Transactions Institution of Engineers & Shipbuilders in Scotland*, Vol. 78, Mar. 1935, pages 320-336. Includes discussion. Investigations carried out in the Glasgow University laboratories on problems which arose in the manufacture of an electrically welded pipe-line are described. For butt-welding plates ½" thick and over, a J profile, with a side slope of 10°, gives better penetration of weld metal and requires less to make a joint than a V profile. Residual stresses were studied, and heating to 600° C. is recommended for their relief. Slow welding causes high stresses; peening relieves them but impairs ductility. A plate-bending type of fatigue machine for testing welds was developed. Tensile, bend, and fatigue tests on welds made with mild steel as well as special electrodes on high-tensile steels are described. These were made on samples as welded and machined flush both before and after heating to 600° C. Mild steel electrodes gave stronger welds in high tensile than in mild steel. It thus appears that some addition elements must alloy with the weld material. JCC (7b)

Repairing Water Wheel Runners by Arc Welding. R. F. MILLER. *Electrical West*, Vol. 74, May 1935, pages 18-19. Report prepared for Production and Generation Committee, Engineering and Operation Section, Northwest Electric Light & Power Association. Describes recent experiences of Portland General Electric Co. in welding pitted areas in bronze and cast-steel runners. Since 1930, P-bronze rods have been used in repairing bronze runners. So far, only pitting found was outside welded areas. Where holes were present, a Cu backing-up plate was used to cover hole, which was closed with first bead. Successive beads, each not more than 3/16 in. thick, were then put on. After every bead, weld was peened lightly. Vanes were ground down to original contour with a high-speed portable grinder. Same procedure was used on cast-steel runners, except that medium-C steel electrode was used. After 4 years' service, only 3 weld deposits showed pitting, due to beads being laid on too far apart. Wheels can be maintained indefinitely, without replacement, at annual cost of not more than $10 per wheel. MS (7b)

Fabrication of Road Machinery by the Electric Arc Welding Process. D. D. TRIMBLE. *Steel*, Vol. 96, June 10, 1935, pages 36-39. Describes practice of J. D. Adams Mfg. Co., Indianapolis, Ind., which involves 2 distinct operations—setup and tack welding and final assembly welding with shielded arc electrodes. Bare and light coated electrodes are used for tacking. Special jigs and fixtures are required. Both steel castings and hot-rolled steel are used in road machinery. Stress relieving is not employed. Technique developed keeps residual stresses down to not more than 5,000 lbs./in². MS (7b)

Rivetless Boiler Tanks (Nietlose Kesseltrommeln). M. ULBRICH. *Zeitschrift Verein deutscher Ingenieure*, Vol. 79, Apr. 13, 1935, pages 463-467. Riveted boilers can not stand the increased pressure of modern development; hence, welded tanks are used. The different welding methods, materials available and metallurgical conditions are discussed. Ha (7b)

The Production of Steel Roof Bodies at Hudson. JOSEPH GESCHELIN. *Automotive Industries*, Vol. 72, Apr. 6, 1935, pages 478-479. Various units of Hudson and Terraplane all steel bodies are joined by combinations of flash, spot, gas and arc welding. The roof section is a single stamping, flanged to fit into main body stampings. It is spot welded by overhead portable welders then electric welded. The joint space is filled with plastic filler from a spray gun then finished with a wide rubber molding. BWG (7b)

Building-up of Rail Ends by Welding (Aufschweissen von Schienenenden). FR. GOLLING. *Autogene Metallbearbeitung*, Vol. 28, May 15, 1935, pages 151-154. Experiences of the Polish State Railways in building-up worn rail ends of steel with 0.5% C, 0.8% Mn, and 0.25% Si with a welding wire of 0.9% C, 0.5% Mn, 0.6% Cr, 0.2% Si, less than 0.03% S+P are described. The oxy-acetylene flame was adjusted to slight excess of acetylene. The Brinell hardness was 240-285. Ha (7b)

7c. Riveting

Notes on the Riveting of High Tensile Structural Steels. WILLIAM BARR. *Structural Engineer*, Vol. 12, Sept. 1934, pages 393-397. Paper before Scottish Branch of Institution of Structural Engineers. Three tables collect data on physical properties of mild and high tensile steel bars and rivets in ordinary tension tests and before and after riveting in relationship to the diameter of the samples and to pneumatic and hydraulic riveting. The experiments show increased strength and loss of ductility of .3 C steel rivets after riveting while ordinary mild steel rivets are but little affected. Due to the plastic nature of mild steel at high temperatures, rivets are easily driven, completely fill the holes and give a high degree of tightness. They also do not deteriorate due to burning. Mean results of tensile and shear properties of a special high tensile rivet steel (analysis not given) before and after riveting are presented showing that the inherent shortcomings of high tensile rivets can be overcome. WH (7c)

8. FINISHING

H. S. RAWDON, SECTION EDITOR

Using a Heated Tumbler for Cleaning, Drying, Polishing and Waxing Many Small Articles. ALBERT POTT. *Industrial Finishing,* Vol. 9, May 1933, pages 12, 14, 18-19. A description of the design, construction and factory operation of steam-jacketed, power-driven tumbling barrels for drying, coating and polishing small metal and wire parts. JN (8)

Cast Aluminum Finishing. J. E. GREENE. *Industrial Finishing,* Vol. 10, June 1934, pages 25. A number of processes are described for finishing cast Al street and road signs. JN (8)

8a. Pickling

Application of Various Etching Methods (Die Anwendung verschiedener Ätzverfahren). EUGEN WERNER. *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Dec. 1, 1934, pages 522-523. Reviews recent progress in superficial etching of designs into metallic surfaces like brass, Cu, Fe, steel and Al. Printing with a fatty ink and subsequent pickling in HNO_3 has widely replaced electrolytic etching. Wax coatings have been generally abandoned. Printing may be accomplished by means of bituminous papers attached to the metal with a spirit varnish. After soaking for removal of the paper, the lacquer is removed and the surface pickled. Steel measuring tapes are first blued in a molten mixture of 4 parts of KOH and 1 part $NaNO_2$ at 300°-400°C. Ni can be deposited on the blue film. EF (8a)

Electrolyte Used with Current Shortens Time of Pickling. *Iron Age,* Vol. 135, June 6, 1935, page 58. A new pickling method developed by Ferro Enamel Corporation, Cleveland, depends on chemical pickling (H_2SO_4) and electrolytic action in an electrolyte composed of an organic acid (gluconic) as well as an inorganic acid. The parts to be pickled do not form part of the electric circuit. The purpose of electrolysis is to regenerate H_2SO_4 from $FeSO_4$. Advantages claimed are longer life of pickling solution, lower acid cost and better finish obtained more rapidly on pickled metal. VSP (8a)

The Corrosion of Steel by Sulphuric Acid. S. RAM. *Journal Society of Chemical Industry,* Vol. 54, Apr. 19, 1935, pages 107T-109T. The laboratory investigations described were designed to determine the influence of acid concentration and presence of $FeSO_4.7H_2O$ on the corrosion rate of iron, a matter of particular practical importance. The following steels were used:

C per cent	0.03	0.26
Mn " "	0.04	0.57
Si " "	trace	0.15
S " "	0.005	0.014
P " "	0.020	0.018
Ni & Co " "	nil	0.09
Cr " "	nil	nil
Heat-treatment after rolling	none	none
Structure	lamellar	lamellar
Thickness in mm.	0.21	0.21

Solutions of H_2SO_4, concentrations shown graphically, were saturated with $FeSO_4.7H_2O$ at 15°-25°C. Conclusions based on results:—(1) Steel corrodes least when H_2SO_4 concentration is less than 780 g./l., when the viscosity of the liquid is increased, and when movement in the liquid is prevented; (2) the presence of $FeSO_4.7H_2O$ appears to have little, if any, effect. AAA (8a)

Sulphuric or Hydrochloric Acid? (Schwefelsäure oder Salzäure?) H. KRAUSE. *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, July 15, 1934, pages 316-317; Aug. 1, 1934, pages 336-337. The relative advantages and shortcomings of H_2SO_4 and HCl for pickling are critically discussed. Disregarding a few exceptional cases, the author concludes that utilization of H_2SO_4 pickling solutions should be retained. Passing mention is given to HNO_3, H_3PO_4 and HF. EF (8a)

8b. Cleaning, including Sand Blasting

Attractive Finish Helps Metal Products Sales. 34—Tumbling and Burnishing. HERBERT R. SIMONDS. *Iron Age,* Vol. 135, Mar. 28, 1935, pages 25-27, 70-72. Outlines some of the features affecting proper selection of equipment, abrasive and process. VSP (8b)

Sand Blasting. *Industrial Finishing,* Vol. 9, June 1933, pages 35-36. Brief discussion of "blast cleaning" of metallic and non-metallic surfaces including types of work done, factors affecting results, safety of workers, and the reconditioning of abrasive materials. JN (8b)

8c. Polishing & Grinding

The Structure of Polished Metal Surfaces. W. R. MEYER & C. C. HELMLE. *Monthly Review American Electroplaters' Society,* Vol. 22, Feb. 1935, pages 29-39. Review of present knowledge on crystal character, cohesion, and amorphous condition of metals, especially at polished surfaces. GBH (8c)

Polishing and Corrosion Protection (Politur und Korrosionsschutz). PLÜCKER. *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Sept. 15, 1934, pages 406-408. Relationship between polishing of metallic surfaces and their corrosion resistance is discussed. States that the porosity of Cr plating is high if the surface of the underlying metal was poorly finished. EF (8c)

8d. Electroplating

Preparation of Nickel Anodes Containing Nickel Oxide for the Prevention of Slime (Herstellung nickeloxydhaltiger Nickelanoden zur Verhinderung der Badverschlammung). *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Aug. 1, 1934, page 339. Drawbacks of ordinary cast and rolled Ni anodes are reviewed. By passing oxygen into a Ni melt, a eutectic of Ni-Ni oxide is formed which is retained in the homogeneous structure of the rolled anodes. With an oxygen content of 0.25%, the Ni anodes go into solution uniformly without the formation of slime. The Ni plated objects exhibit a smooth bright surface. EF (8d)

Electroplating in Malaya. WALTER BUCHLER. *Platers' Guide,* Vol. 31, Apr. 1935, pages 11-12. Modern English methods of plating are employed. WHB (8d)

Contribution to the Electrochemistry of Magnesium (Second Communication) (Zur Elektrochemie des Magnesiums (Zweite Mitteilung)). SVEN BODFORSS & HARALD KAJMER. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 171, Dec. 1934, pages 190-198. Determinations of the electrolytic potential and rate of dissolution of several specimens of very pure Mg in various buffer solutions, and of the effect of additions of sodium fluoride, ammonium sulphate or pyrocatechin on the potential. The potentials of the various specimens differed. Apparently this should be attributed primarily to differences in microstructure and, secondarily, differences in purity. In all cases, however, upon variation of the Mg potential with varying H potential the "pH-effect," the "anion effect," and the "agitation effect" were observed. The rate of dissolution of Mg in any buffer solution is constant and proportional to its acid content; it is practically independent of its ratio: acid content/salt content. It increases in the following acids, citric acid, malonic acid, succinic acid, acetic acid, formic acid, in the order of mention, being about proportional to the dissociation constant (corrected by the statistical factor) of the individual acid. The rate determinations agree with those of Kilpatrik & Rushton whose results are critically discussed. ORS (8d)

Tin Plating of Pistons Is Held Under Close Control. FRED B. JACOBS. *Steel,* Vol. 96, Mar. 18, 1935, pages 50, 52. Describes practice of White Motor Co. Only skirt of piston is Sn plated, thickness of coating being 0.001". For plating, 8 pistons are loaded on a rack, arms of which are machined accurately to fit piston-pin holes. Exposed parts of rack are protected against plating by electrician's tape. Outside piston-pin holes are fitted with wood plugs and piston tops are protected by rubber-coated caps. Plating tank 15' x 5' is double. Outer part contains H_2O which is heated with natural-gas to maintain bath at 160° F. Voltage is 2-4 and amperage, 100. MS (8d)

The Microstructure of Electrodeposited Coatings. *Metal Cleaning & Finishing,* Vol. 7, Feb. 1935, page 86. Abstract of paper read by A. W. Hothersall at a joint meeting of the Midland Metallurgical Societies and the Midland Centre of the Electrodepositors' Technical Society (England). Classifies 3 types of crystal structure; symmetrical groups of crystals, conical compact deposits, and broken or powdery structures. Current density affects structure. In acid copper plating 5 amps./ft.^{2} produces coarse, 10 amps./ft.^{2}, fine; and 20 amps./ft.^{2} twinned crystal structure. Fine-grained deposits are hard; coarse-grained, soft. GBH (8d)

Electrodeposition of Iron for Wearing and Bearing Metal. DAVID R. KELLOGG. *Metals & Alloys,* Vol. 6, Apr. 1935, pages 97-99. 8 references. Describes the bearing and wear characteristics of electro deposited Fe coatings. Such coatings have been used to repair shafts, gages and the like and have given excellent results in service. Study of bath conditions giving best coatings covers cold baths 75 g. $Fe(NH_3)_2(SO_4)_2$/l. with pH 10^{-6} and current density of 0.33 amp./dm.^{2} and hot baths 300 g. $Fe(NH_3)_2(SO_4)_2$/l., pH 7 x 10^{-6} to 2 x 10^{-6}, 50-70° C. and current density 6.7 amp./dm.^{2} Additions of ferrous carbonate mud and charcoal with stirring appear to be beneficial in producing an adherent coating in both baths. Faster plating and higher current efficiency are obtained with the hot bath. Stoneware containers were used; the presence of wood in the solution was found to be very harmful. WLC (8d)

The Electrodeposition of Cadmium in Electrical Engineering. H. MARSTON. *Journal Electrodepositors' Technical Society,* Vol. 10, 1934-5, pages 57-68. Paper read before the Society, Mar. 13, 1935. Advantages of Cd over Zn consists in the denser Cd deposit (.0004" Cd compares well with .001" Zn in rust-proofing), the more rapid deposition of Cd and longer life in salt spray (Cd 300 hrs., Zn 180 hrs.). Cd fails when subjected to steam erosion, also when in contact with hydrocarbon oils, or body perspiration. English commercial plating practice, solution formulas, and analytical methods are described. GBH (8d)

Bus Bars for Electrochemical Plants. L. C. PAN. *Electrometallurgy,* supplement to *Metal Industry,* London, Vol. 45, Oct. 5, 1934, pages 327-329. Paper presented at the 66th General Meeting of the Electrochemical Society, held in New York City Sept. 27-29, 1934. Author points out that an IR loss which is practically insignificant on high voltage is a serious factor in low-voltage work such as electro-refining, electro-winning of metals, electric furnace work, electroplating and electro-chemical processes where large amperages are used at low voltage. Therefore for any low-voltage installation bus-bar design must be based on a minimum IR drop at a minimum cost. Factors to be considered are (1) interest on investment, (2) amortization, and (3) cost of power to overcome the resistance of the bus-bar. Equations are given for determining the most economical current density in amp./cm.^{2} and the most economical cross-section area for the bus-bar in cm.^{2} Both are independent of the distance between the generator and point of application. A practical example is given. A comparison is drawn between Al and Cu bus-bars and it is concluded that the cost of the metal is the deciding factor as to which is more economical. HBG (8d)

8e. Metallic Coatings other than Electroplating

Gold Foil (Blattgold). *Metallwaren Industrie & Galvano Technik,* Vol. 32, Oct. 15, 1934, pages 451-453. Commercial uses of Au foil are reviewed. When coating Fe and steel with Au foil, the former are pickled in HNO_3 and heated. The Au foil is pressed on with the burnisher (polishing iron) and firmly adheres to the underlying metal. If high-purity Au foil has been utilized, luster and color will be preserved for years under atmospheric corrosion conditions. Ag and Cu markedly change the color of Au foil. "Lemon gold" contains only 750/1000 Au and a high percentage of Ag. Dark-green and light-green Au respectively contain 667/1000 and 585/1000 Au. The laborious preparation of Au foil is discussed at length. 2 Manual labor cannot be replaced by machine work. The ductility is more pronounced if made by hand. Ag and Pt can be reduced to thicknesses of only 1/4500 mm. Dutch gold (Rauschgold) contains no Au; it is brass of 1/1000 mm. thickness and tarnishes readily in the atmosphere. A lengthy historical review of Au foil production is given dating back to 3000 B. C. The latest invention of Carl Müller of the Physikalische Reichsanstalt, Berlin, led to electrolytic preparation of Au foil of 1/100,000 mm. This is transparent while the hand-made Au foil is only translucent. With the Müller process, Au remains unsurpassed as equivalent amounts of other metals furnished foils having only half the surface area of Au. EF (8e)

3

Residuum Losses in Galvanizing. W. H. Spowers, Jr. *Industrial Heating,* Vol. 2, May 1935, pages 239-243. The author gives some data on very great losses in the residuums of galvanizing processes. About 291,000 tons of Zn are used yearly for galvanizing purposes (value about $29,000,000) while the loss amounts to approximately $4,400,000. The causes of dross discussed are improper firing, improper containers, active flux, oxide loss. The remedy depends on utilizing the recent results of scientific investigations in this field. Ha (8e)

4

The Lowdown on Sprayed Metal Coatings. *Power,* Vol. 79, Mar. 1935, pages 143-144. Discussion of "Experiences in the application of sprayed metal coatings" before Power Division, American Society of Mechanical Engineers, New York, Feb. 6. Sprayed Pb coatings best resist corrosion of East River water provided the base metal has been properly prepared. Phosphor bronze layers up to 1¼" thick have been applied on salt water pumps. Zn is applied first to a clean cast-Fe surface, then bronze over the Zn. Operating directions and precautions are given. Sand blasting gives a better surface than a steel-grit blast. Recent advances in spraying combustion chambers of internal combustion engines with Al are described. 5 It is stated that such a surface slows up the combustion rate, gives up heat to gases during the compression cycle and so lowers the skin temperature. Pre-ignition is prevented and C formation within the cylinder is reduced. Methods for closing pores in coatings are described. Steel containing up to 1.2% C has been sprayed successfully. AHE (8e)

Coloring of Copper Alloys with Black Stain (Über Färben von Kupferlegierungen mit Schwarzbeize). Georg Gross. *Chemiker-Zeitung,* Vol. 59, Mar. 6, 1935, pages 195-196. A solution of freshly precipitated $CuCO_3$ in strong NH_4OH is used to form a coating of black CuO. Wires for suspending the articles must not be used because of contact currents. 6 The articles must be moved about in the solution continuously so that O dissolves in it and NH_4OH content is not reduced. Brasses with 55-65% Cu are best. The time necessary increases with increasing Cu content. CEM (8e)

8f. Non-Metallic Coatings

7

The Determination of the Suitability of Bituminous Coatings for Underground Pipes. Geoffrey Owen Thomas. *Transactions & Journal of the Institution of Engineers of Australia,* Vol. 6, Oct. 1934, pages 337-346. *Appendix I:* **Method of Preparation of Coated Plate Specimens.** *Appendix II:* **Method of Preparation of Water Absorption Specimens.** *Appendix III:* **Description of an Electrical Test for Determining the Rate of Penetration of Water into a Mass of Bituminous Material.** *Appendix IV:* **Economics of Pipe Coatings.** Deals with testing of bituminous materials to determine their suitability as pipe coatings. Standard tests are discussed together with methods evolved to obtain additional data and some results given in 3 tables. 25 different bituminous materials were tested under the following conditions: wet + dry, service reservoir, sewer, weather, 8 dilute acid solutions, NH_4Cl solution and not exposed (storage). Coal tars and their pitches together with prepared enamels (coal tar base) proved outstandingly the best water resistants with vertical-retort tar considerably inferior to horizontal-retort and coke-oven tar. Failures of these generally occurred when the tar contained impurities such as coal dust or if the pitch was very brittle. All mixtures of natural asphalt, whether with tar or bitumen, with over 50% asphalt showed a peculiar type of physical disintegration. Residual oil bitumens appear to be quite stable chemically, but will not "wet" the plate permanently in preference to water. Adhesion breaks down and every specimen over 2 years old showed considerable staining of the plate usually with a layer of rust between plate and 9 coating. The latter peels off readily when scraped. This phenomenon is due to the high surface tension of oil bitumens and warrants their rejection as suitable pipe coating material. The addition of mineral fillers to bitumen appears to hasten this breakdown of adhesion. Attempts to improve the adhesion of bitumen by applying it over a coal tar primer have been unsuccessful. Only prepared bituminous paint was found to be as suitable as coal-tar pitches but its cost is beyond the economic limits of pipe coatings. The coating process for steel pipes in Melbourne takes the following steps: degreasing and derusting of pipe, heating to 250°-400° F., dipping into priming tar (light horizontal-retort tar), dipping for 10 min. (rotating slowly) into a bath of horizontal-retort coal tar pitch, 10 wrapping with mixture of coal tar pitch + 200 mesh limestone (40%) sprinkling on of fine sands, and white washing. The determination of the rate of water absorption by the bituminous material is considered as the most important test. A discussion of a rational method of determining the economical thickness of coatings is appended. WH (8f)

Titanium Compounds and Application Thereof in Vitreous Enamels. C. J. Kinzie & A. Plunkett. *Journal American Ceramic Society,* Vol. 18, Apr. 1935, pages 117-122. Study of the effect of titania, alumina, zirconia, silica, tin oxide and antimony oxide on thermal dilation, melting point and fusion flow properties of a simple enamel melt. TiO_2 increases the fluidity of enamel melt, and glasses or frits at 1520° F. are more fluid than those to which like additions of Al_2O_3, ZrO_2, SiO_2, SnO_2 and Sb_2O_3 were made. Various colors were obtained in some of the enamels through combination of the TiO_2 with Zn and Al. Acid-resisting enamel can be prepared with Sb_2O_3 and TiO_2 up to and above 4% titania. As an opacifier TiO_2 is not suitable as a mill addition because of its powerful fluxing action. Enamels can be made opaque with TiO_2 alone but the enamel will be colored and not white. WB (8f)

Prefinished Sheets Cut Assembly Costs. Harold B. Veith. *Steel,* Vol .96, Mar. 4, 1935, pages 49, 58. Application of finish coatings to steel sheets before material is processed has made possible reproduction of wood grain, inlays, and other designs, and reduced cost of fabrication. Market for material is extensive. MS (8f)

Micro-Gas Analysis of Gas Trapped in Vitreous Enamels on Enameling Iron During Firing. S. E. Freeman & V. W. Meloche. *Journal American Ceramic Society,* Vol. 18, Apr. 1935, pages 123-125. The methods and materials for micro-gas analysis are given in the text. A series of 4 analyses are shown with complete composition tabulated. WB (8f)

Directions for Coloring Aluminum Medals (Anweisung zum Färben von Aluminium-Plaketten). K. Vollrath & G. Lahr. *Oberflächentechnik,* Vol. 12, Feb. 5, 1935, page 30. Supplementing their information on coloring of Al (*Aluminium,* Dec. 1934, page 209; see *Metals & Alloys,* Vol. 6, Apr. 1935, page MA 158) the following recipes are given: 1. Red-brown. Cu-plating in an ammoniacal $CuSO_4$ solution to which KCN has been added until it is colorless. The Al object is pickled in NaOH and then dipped into the boiling solution. 2. Old silver. First Cu-plated (according to 1.) Al object is Ag-plated in an ammoniacal $AgNO_3$ solution to which KCN is added until it is colorless, by dipping it in the solution at room temperature. 3. Yellow gold-gray. The Al is immersed for 20 min. in a solution of 2% $KMnO_4$+0.5% $CuSO_4$ at 80°-90° C. 4. Dull iron color. Immersion in a solution of 2.5% K_2S+0.2% vanadium sulphate at 80°-90° C. for 30 min.; the same color but bright is obtained by first scrubbing the article with steel wool. 5. yellow-red. Immersion in 2.5% K_2S+0.1% alizarine+0.1% morine at 80°-90° for 20 min. 6. Bronze. Immersion in 2.5% K_2S+0.1% morine at 80°-90° for 30 min. 7. Yellow-gold with slight silver tint. Immersion in 2.5% K_2S+0.1% morine and a trace of alizarine at 80°-90° for 10 min. Ha (8f)

Surface Treatment and Painting of Dowmetal. Dow Chemical Co. 7-page supplement to Dowmetal Data Book, dated March 1, 1935, covers: cleaning, chemical treatment, chrome-pickle, chrome-phosphate, painting, primers, surfacers, finishes, baked finishes, and colored finishes. (8f)

9. TESTING

The Testing of Materials. Cecil H. Desch. *Proceedings South Wales Institute of Engineers*, Vol. 50, Feb. 12, 1935, pages 449-474. A review of the tensile test, hardness test, notched bar test, creep testing, fatigue, and macro- and micro- examination. AHE (9)

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Organization of the Metallographic Department of the Trinec Mills (Organisation de la Séction Métallographique des Forges de Trinec). Bohuslar Otta. *Chimie et Industrie*, Vol. 29, June 1933, pages 606-611. Industrial tests at Trinec give the following results: Fracture may be caused by (1) the mechanical fatigue of the material, (2) formation of blisters on the distributor of steam turbines made of gray cast iron, the blisters being caused by S inclusions produced during casting, (3) the presence of a phosphorus eutectic in steel castings, (4) the influence of Cr on the welds of mild steel, tests showing that even a minute quantity of Cr exercises a very adverse influence on the quality of the welds of tubes. MAB (9a)

Radiology in the Welding Art. V. E. Pullin. *Engineer*, Vol. 159, Apr. 19, 1935, pages 402-405. Discussion of X-ray examination of welds including cost of equipment, labor and dangers. X-rays give only a partial indication of the soundness of lap welds. Butt welds, on the other hand, are capable of complete X-ray examination. X-ray spectrum analysis of welds is confined to the laboratory. VSP (9a)

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Hardness Conversions for Carbon and Alloy Steels. John H. Hruska. *Iron Age*, Vol. 135, Apr. 18, 1935, pages 20-21, 90, 92, 94, 96. Reviews all of the usual testing methods and includes table giving comparative figures which are believed to be the most accurate yet assembled. Work of other investigators have shown surprising variations. Results obtained from practical applications of various methods and instruments of hardness testing show that machine by Vickers gives the most uniform basis for comparisons with other testing procedures. Lack of accuracy at the higher hardness values of the Brinell method places the Vickers ahead. This table applies only to chemically and mechanically uniform steels containing C, Cr, Ni, V, Mo, Si and Mn, none of the alloys exceeding 4%. No cold worked steels are included. Detailed notes on observations made during investigation are included. VSP (9b)

Model Illustrating the Reactions in Stressed Materials (Modell zur Veranschaulichung der Vorgänge in belasteten Werkstoffen). W. Späth. *Archiv für das Eisenhüttenwesen*, Vol. 8, Mar. 1935, pages 405-418. On the basis of the similarity of the stress-strain curve of periodically stressed materials with the work curve of machines, the reactions during the loading of materials is illustrated by a model. According to this, the relations observed in practice between the load and deformation in static and repeated loading is explained. The reactions during repeated stressing are discussed in detail, including the effect of pretreatment of the material, rate of loading, and max. load on the damping and endurance properties. SE (9b)

A S T M Committees Approve Standards and New Projects. *Industrial Standardization*, Vol. 6, Apr. 1935, pages 96-99. Review of reports on test methods and specifications. WB (9b)

Apparatus for Measuring Thermal Conductivity of Metals up to 600° C. M. S. Van Dusen & S. M. Shelton. *Bureau of Standards Journal of Research*, Vol. 12, Apr. 1934, pages 429-440. The method employed consists in comparing the conductivity of a metal, either directly or indirectly, with that of lead. Lead was selected as standard since previous measurements have established its conductivity within fairly close limits. Data are given on the conductivity of commercial Ni, high purity Zn, high purity Ni, and several commercial Ni-Cr and other alloys widely used for heating elements and thermocouples. WAT (9b)

Wear and How to Determine It. W. A. Harrington. *Heat Treating & Forging*, Vol. 21, May 1935, pages 233-237. Paper read before Steel Treatment Research Society, Australia. For determining relative amount of wear, author has devised machine, principle of which involves bringing specimens in form of arc of known radius and standard width into rubbing contact with a track and measuring by means of a calibrated microscope the length of chord worn on specimens. By means of this reading, ratio of wear on 2 specimens can be obtained from a specially prepared table. Machine consists of rotating table on which is mounted a flat annular track of any desired material. Holder carrying 2 specimens which are set equi-distant from a ball pivot is pivoted on a mounting attached to a beam, which is calibrated to give the desired load for rubbing contact by moving a weight. Specimens are oscillated across full width of track, provision being made for lubrication or application of abrasive. Describes tests carried out on cast-Fe. Results indicate that hardness has little definite influence on wearing quality. Cast-Fe with pearlitic structure shows best resistance to wear, rate depending upon amount and form of pearlite. Load plays an important part, but no definite relation was established. Tensile properties have practically no relation. Grain size, though not fully investigated, is thought to exercise considerable influence. MS (9b)

9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

Rear Axle Gears: Factors which Influence their Life. J. O. ALMEN & A. L. BOEGEHOLD. *Preprint, American Society for Testing Materials,* 1935, 37 pages. Describes a testing machine for making endurance tests on full-size rear-axle assemblies of automobiles. Test results in the General Motors Research Laboratories show that gear tooth failures may be plotted on the familiar S-N diagram when the gear stresses are properly calculated. The McMullan and Durkan modification of the Lewis formula gave consistent results for stress in gear teeth. Showed that the chief benefit obtained from using alloy steels came from the lowered amount of distortion in such steels when heat treated, resulting in more uniform tooth contact and reduced stress concentration. Ordinary fatigue tests of several gear steels and fatigue tests of notched specimens did not give reliable indices of service values, and the authors say, "The sensible thing to do is to pick a steel with due regard to the possibility of heat treating that steel without undue distortion." Distortion and misaligment of gear teeth seem a more serious cause of service failure than the strength properties of the steel itself. HFM (9c)

High-Speed Fatigue Tests of Several Ferrous and Non-Ferrous Metals at Low Temperatures. W. D. BOONE & H. B. WISHART. *Preprint, American Society for Testing Materials,* 1935, 5 pages. A rotating-cantilever fatigue machine with a speed of 12,000 r.p.m. was developed at the University of Illinois, and fatigue tests of duralumin, brass, cast iron, cold-drawn steel, and rail steel were made at temperatures varying from +80° F. to —40° F. Tests were also made on notched specimens. In general, as the temperatures were decreased the endurance limit increased. The stress concentration factors in the notched specimens showed no consistent change with temperature. The low temperature tests were made in the cold room of the U. S. Air Service Laboratories at Wright Field, Dayton, Ohio. HFM (9c)

Report of Research Committee on Fatigue Metals. H. F. MOORE, Chairman. *Preprint, American Society for Testing Materials,* 1935, 10 pages. Progress report of work of Committee. Reports coöperation with Committee on Metallography. So far widening of Debye lines of an X-ray spectrogram has been shown after many cycles of stress for Si steel, but not for Al. This widening is probably an indication beneficial cold-working. Some promise is held out that widening of diffraction spots may give some indication of progress of fatigue in ferrous metals. Tests are being continued. Report also gives notes on fatigue tests on rotating-beam testing machines, commenting on desirable and undesirable technique in making such tests. HFM (9c)

The Rotating-wire Arc Fatigue Machine for Testing Small-diameter Wire. J. N. KENYON. *Preprint, American Society for Testing Materials,* 1935, 9 pages. A stress-reversal fatigue machine on the principle of a rotating wire bent into a circular arc has been developed at Columbia University for testing small-diameter wire. Resonant vibrations of standing waves of stress are effectively dampened in an oil bath. The specimen automatically assumes the form of a circular arc by the elimination of flexural shear. Tests so far carried out give reasonable and consistent values for small diameter wire, with breaks usually several inches away from the bearings in which the wire rotates. The following values have been obtained for commercial materials.

Material	Tensile Strength lbs./in.²	Endurance Limit lbs./in.²	Endurance Ratio
Piano wire (0.85 C)	374,000	108,500	0.290
Cold-drawn steel wire (0.66 C)	282,000	95,000	0.340
Cold-drawn steel wire (0.62 C)	275,000	79,500	0.290
Copper-beryllium (2.22 Be)	132,500	31,500	0.240

HFM (9c)

Notch Sensitivity of Steels in Fatigue. J. B. KOMMERS. *Engineering,* Vol. 139, Mar. 1, 1935, page 225. Letter to the editor commenting on articles by B. P. Haigh in *Chemistry & Industry,* Jan. 11, 1929 on "Relative safeties of mild- and high-tensile alloyed steels under alternating and pulsating stresses," a similar article published in *Automobile Engineer,* Feb. 1930 and in *Engineering,* Dec. 28, 1934, p. 698 on "Fatigue in structural steel." Notch sensitivity of metals is of great practical value and results presented indicate that high ultimate tensile strength of some steels is not always reflected to same extent in endurance limit of specimens subjected to stress concentration effects. Since results obtained may be influenced by various factors, the procedure indicated is to make appropriate experimental determinations in comparing various steels. VSP (9c)

Corrosion-Fatigue Properties of Duralumin. I. J. GERARD & H. SUTTON. *Engineering,* Vol. 139, Mar. 15, 1935, pages 289-290. Paper read before the Institute of Metals, Mar. 1935. See *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 65. VSP (9c)

The Relation of Fatigue to Modern Engine Design. FREDERIC BACON. *Mechanical World & Engineering Record,* Vol. 97, Mar. 8, 1935, pages 227-228. Abstract of a paper presented to the North-East Coast Institution of Engineers & Shipbuilders. See *Metals & Alloys,* Vol. 6, May 1935, page MA 200. Kz (9c)

Accelerated Cracking of Mild Steel (Boiler Plate) Under Repeated Bending: Part II. Further Tests. C. H. M. JENKINS & W. J. WEST. *Iron & Steel Industry,* Vol. 8, Oct. 1934, page 22. Abstract of paper presented at the Iron & Steel Institute Meeting in Belgium. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 577. CEJ (9c)

10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

The A_1 Transformation Region in Abnormal Steels (Der A_1-Umwandlungsbereich bei anormalen Stählen) H. CORNELIUS. *Archiv für das Eisenhüttenwesen,* Vol. 8, Apr. 1935, pages 461-463. The temperatures of the Ac_1 and Ar_1 transformations were determined in a large number of ordinary crucible steels and very pure carbonyl steels with from 0.1 to 1.7% C. Abnormality was found to be a characteristic of the purest steels. In these the rate of diffusion of C is very great, which is indicated by the earlier beginning of the Ac_1 and Ar_1 transformations, and the smaller hysteresis between these points. In abnormal steels the cementite diffuses to the earlier formed cementite particles, causing coalescence of the cementite and the appearance of free ferrite even in hypereutectoid steels. SE (10)

Preparation of Lead and Lead-Rich Alloys for Microscopic Examination. W. H. BASSET, JR. & C. J. SNYDER. *Metals & Alloys,* Vol. 6, May 1935, pages 125-129. 8 references. Describes methods of microtoming, machining, and polishing Pb alloys for micro-examination. In using cutting tools, the layers removed must be very thin and smearing or working action of the tool held to a minimum. Polishing is done manually on lubricated emery paper backed by plate glass. Etching reagents and their method of use are tabulated; typical micrographs are shown. WLC (10)

Detection of Lattice Disturbances and its Importance in Testing Materials (Kritische Betrachtungen über den Nachweis von Gitterstörungen und seine Bedeutung für die Materialprüfung) F. REGLER. *Mitteilungen des Technischen Versuchsamtes, Wein,* Vol. 33, 1934, pages 8-17. Experiments to determine the elastic forces acting upon a material by measuring the increase of lattice distortion as evidenced by increase of the width of X-ray interference lines showed that the lines are widened not only by static stresses, but also by any mechanical or thermal stress. A great number of examples illustrates how deep these disturbances penetrate into the material and how this depth depends on material and its treatment. Every material of a given chemical composition possesses at the place of fracture a maximum width of interference line, which is characteristic for the material. This value is a material constant and entirely independent of the manner by which fracture occurred, whether tearing, hammering, or fatigue, and also independent of the previous treatment of the metal. The width of the lines is a measure of the lattice distortions at which the atomic ties are dissolved. Attention is called, however, to the fact that the X-ray does not replace the usual testing methods, but should be applied where an insight into the atomic structure of the material is wanted. Ha (10)

Association of Flakes and Dendrites. B. M. SUSLOV. *Metal Progress,* Vol. 27, May 1935, pages 56-58. Reports experiences of Russian steel works indicating that slow cooling is the preventive for flakes in alloy forging steels. WLC (10)

Influence of Silicon on Critical Points and the Constitution of Chromium Alloys (Influence du Silicum sur les points Critiques et la Constitution des Alliages au Chrome). E. VALENTA & F. POBORIL. *Chimie et Industrie,* Vol. 29, June 1933, pages 633-648. Influence of Si on constitution of alloys of Cr was studied in the 2 sections of system Fe-C-Cr, (0.8% C and 25% Cr), and also at the base of the 2 sections of system Fe-C-Cr-Si, with 2.5% Si, 0.8% C, and 25% Cr. Metallographic studies on the formation of the eutectic as well as thermal analyses and dilatometric studies and hardness tests after annealing, are described. Si reduced the γ-phase region and enlarged the α-phase region. By raising the critical points, the zone of the alloys between the critical points was enlarged. Si moreover reduced the quantity of C in the eutectic. The authors present an Fe-C-Cr system based on this study and on those of Phragmén, Westgren, Negresco and others. Many graphs and tables. MAB (10)

Constitution of Antimony-tin-zinc Alloys (Sur la Constitution des Alliages Antimoine-Étain-Zinc) ROBERT BLONDEL & PAUL LAFITTE. *Comptes Rendus,* Vol. 200, Apr. 24, 1935, pages 1472-1474. In the ternary system Sb-Sn-Zn used as antifriction alloys, 3 peritectics have been identified p_1 (Sb 0.5, Sn 91.5, Zn 8.0), p_2 (Sb 8, Sn 91, Zn 1), p_3 (Sb 53, Sn 40, Zn 7). In the binary system Sn-Zn, there is a solid solution rich in Sn containing 2.5% Zn. FHC (10)

Electron-microscope Pictures of Minerals (Abbildung von Mineralien mit dem Elektronenmikroskop) H. MAHL. *Zeitschrift für Kristallographie, Abt. B, Mineralogische & Petrographische Mitteilungen,* Vol. 46, 1935, pages 289-292. For the first time, the electron microscope has been utilized to study minerals; some remarkable pictures of galena and chalcopyrite, embedded in Wood's metal, are reproduced and compared with ordinary photomicrographs. Detection and resolving power in regard to inclusions are stressed. EF (10)

Transformations in Iron-aluminium Alloys. C. SYKES & H. EVANS. *Iron & Steel Institute,* May 1935, Advance Copy No. 8, 23 pages. Fe-Al alloys containing from 7.8 to 15.4% Al were studied. Atomic rearrangement (ordering) and magnetic changes were detected by cooling curves, electric resistance, and magnetic measurements. The heat evolution due to ordering starts at about 500° C. and continues over a range of temperature, probably to 200° or 250° C. Measurement of electric resistivity of samples quenched from various temperatures indicated transformation temperatures in agreement with those obtained by purely thermal methods. Determination of magnetic change points indicated that the ordering process can in certain alloys of the approximate formula Fe_3Al affect the magnetization-temperature curve. 14 references. JLG (10)

X-Ray Study of Copper-silver Alloys. E. A. OWEN & JOSEPH ROGERS. *Journal Institute of Metals,* Vol. 57, Apr. 1935, pages 173-184 (Advance Copy No. 699). Solid-solubility limits at both ends of the Cu-Ag system were determined by X-ray methods. Results were in general agreement with those of Ageew, Hansen, and Sachs and with Stockdale but not with those of Lepowski. Solubilities of Cu in Ag found were 8.5% at 778° C., 6.1% at 700 °C., 3.3% at 600° C., 1.8% at 500° C., 0.7% at 400°C., 0.4% at 300° C., 0.2% at 200° C., and 0.1% at room temperature; values for the highest and lowest temperatures were obtained by extrapolation. Solubilities of Ag in Cu were 8.4% at 778° C., 5.5% at 700° C., 2.9% at 600° C., 1.4% at 500° C., 0.5% at 400° C., 0.2% at 300° C., 0.1% at 200° C., and almost insoluble at room temperature as judged by extrapolation; the solubility for the highest temperature was obtained by extrapolation. JLG (10)

Constitution of Lithium-cadmium Alloys. 13 (Konstitution der Lithium-Kadmium-Legierungen. 13). E. ZINTL & A. SCHNEIDER. *Zeitschrift für Elektrochemie,* Vol. 41, May 1935, pages 294-297. X-ray study of Li-Cd alloys is reported for 4 intermediate phases, corroborating the thermal, conductivity and dilatometric results of G. Grube, H. Vosskuhler & H. Vogt, *(Zeitschrift für Elektrochemie,* Vol. 38, page 869, 1932). WB (10)

Constitution of Lithium-bismuth Alloys. 14 (Konstitution der Lithium-Wismut-Legierungen. 14.) E. ZINTL & G. BRAUER. *Zeitschrift für Elektrochemie,* Vol. 41, May 1935, pages 297-303. X-ray study of Li-Bi alloys is reported for 2 intermediate phases, corroborating the work of G. Grube, H. Vosskuhler & H. Schlecht, *(Zeitschrift fur Elektrochemie,* Vol. 40, page 270, 1934). WB (10)

Non-metallic Inclusions in Ferro-alloys. B. MATUSCHKA. *Iron & Steel Institute,* May 1935, Advance Copy No. 6, 8 pages; *Iron & Coal Trades Review,* Vol. 130, May 3, 1935, pages 764-765. After a general discussion of inclusions in steel the inclusions in metals and ferroalloys often added to steels are described. Materials considered are Fe-W, Fe-Cr, Ni, Fe-Mo, Co, Fe-V, Fe-Mn, Fe-Si, Al, and Cu. JLG + Ha (10)

The Structure of Steel. II. *Edgar Allen News,* Vol. 13, May 1935, pages 646-647. Meaning of equilibrium diagrams and alloy phases and their usefulness to the metallurgist are explained. Ha (10)

The Microstructure of Cast Iron. E. C. ROLLASON. *Welder,* Vol. 7, Jan. 1935, pages 430-434; Mar. 1935, pages 486-491. General review of characteristics and uses of cast iron. Ha (10)

Crystal Structure of β Manganese and Isomorphous Alloys (Über den Kristallbau des β—Mangans und isomorpher Legierungen) SVEN FAGERBERG & A. WESTGREN. *Metallwirtschaft,* Vol. 14, Apr. 5, 1935, pages 265-267. The β modification of Mn is cubic and one elementary cell contains 20 atoms. Ag_3Al, Au_3Al, Cu_5Si and $CoZn_3$ have similar structures. X-ray powder photograms, using short-wave Cu rays, were taken of Ag_3Al, Au_3Al and Cu_5Si and identical structures were obtained. On account of its smaller lattice dimensions the angles of deflection of Cu_5Si are different from the other two. The 20 atoms in these alloys are regularly distributed at 2 points, 8 (c) and 12 (d). By correct choice of the parameters of these 2 points the intensities of diffraction rings were calculated and were found to agree perfectly with the observed intensities. The 20 atoms of the elementary cube are grouped in a diagram into four groups each containing five atoms. It is evident that β Mn and its isomorphous alloys have a coördinated, but not a molecular lattice structure. 8 references. CEM (10)

Globulite: Spheroidized Cementite. A. GLAZUNOV. *Metal Progress,* Vol. 27, May 1935, page 56. Suggests "globulite" as term for spheroidized cementite. WLC (10)

11. PROPERTIES OF METALS AND ALLOYS

Brittleness in Ductile Engineering Structural Materials. W. E. LEWIS. *Metallurgia*, Vol. 11, Apr. 1935, pages 147-148, 150. From paper given at Institution of Engineers & Shipbuilders in Scotland. Gives data to show advantage of impact test in detecting brittleness in cast steel. Also discusses brittleness in wrought steels and non-ferrous alloys. JLG (11)

Metallic Resistance Materials. A. SCHULZE. *Engineering Progress*, Vol. 16, Apr. 1935, pages 109-112. Materials for precision and industrial resistance are reviewed; compositions and properties of manganin (for the former) and Fe alloys for uses up to 1300° C. are described. 10 references. Ha (11)

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Effect of Bismuth as an Impurity on the Structure and Allotropic Transformation of Tin. C. W. MASON & W. D. FORGENG. *Metals & Alloys*, Vol. 6, Apr. 1935, pages 87-90. 6 references. Work reported shows as little as 0.0035% Bi in Sn will cause cored structure which is revealed by etching in 5% HNO_3 in absolute alcohol. This Bi content inhibits transformation from white to gray Sn unless extreme coring produces very pure ribs along which inversion may progress through the crystals. An electrolytic method for preparation of pure Sn is described. WLC (11a)

Aluminum-Copper-Nickel Alloys of High Tensile Strength Subject to Heat Treatment. W. A. MUDGE & PAUL D. MERICA. *Metals Technology*, Apr. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 619, 12 pages. A new series of corrosion-resistant alloys with a wide range of mechanical properties developed through heat treatment is described. The alloys contain 3 to 5% Al, 40 to 90% Ni, and balance Cu. A typical alloy is made by the addition of 4% Al to Monel metal. The alloy is softened by quenching from 1500° F. and maximum hardness and strength are developed by tempering at 1075° to 1100° F. As-quenched tensile strength and hardness are the same as for hot-rolled Monel, but when hardened the yield point is 120,000 lbs./in.^{2}, the tensile strength 160,000 lbs./in.^{2}, the elongation in 2 in. 20%, and the Brinell hardness 330. Modulus of elasticity in tension is 26,000,000 lbs./in.^{2} The alloys have the same corrosion resistance as Monel. They can be hot and cold worked, but are not malleable in the temperature range 900° to 1500° F. They can be machined by the methods recommended for Monel when Brinell hardness is less than 300. The mechanism of hardening by heat treatment is not yet clear. It probably relates to a phase transformation between 1100 and 1500° F. involving a ternary compound of Al, Cu and Ni. 10 references. JLG (11a)

Influence of Heat-treatment on the Fatigue and Corrosion Resistance of Aluminum Bronze (Influenza del trattamento termico sulla resistenza alla fatica ed alla corrosione del bronzo d'alluminio). I. MUSATTI & L. DAINELLI. *Alluminio*, Vol. 4, Jan.-Feb. 1935, pages 51-63. Al bronzes of the 90 Cu- 10 Al type show maximum resistance to fatigue and corrosion when tempered at 600° C. The presence of the eutectoid phase increases corrosion by HNO_3, but decreases the corrosion by HCl or H_2SO_4. Hardening and tempering increases the resistance to corrosion by HNO_3, but does not influence the resistance to HCl and H_2SO_4. AWC (11a)

Physical and Casting Properties of the Nickel Silvers. T. E. KIHLGREN, N. B. PILLING & E. M. WISE. *Metals Technology*, Feb. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 610, 31 pages. Systematic data are given on the relation of composition of Ni brass to color, tarnish resistance, hardness and liquidus temperatures, for alloys containing up to 30% Ni and 50% Zn. Data are also given for alloys containing as much as 8% Sn and as much as 10% Pb. For a more limited field of alloys there are data on tensile strength, and such casting properties and characteristics as fluidity, shrinkage and pressure tightness. The effect of varying composition within the ranges listed in Federal Specification for 20% Ni casting alloy, WWP-541, on tensile properties was determined. Alloys that are to be pressure tight should not be deoxidized with Si; deoxidation with 0.10% Mn, 0.05% Mg and finally 0.02% P is satisfactory. 17 references. JLG (11a)

Inconel—An Alloy For Textile Wet Processing Equipment. F. L. LA QUE. *American Dyestuff Reporter*, Vol. 24, Mar. 11, 1935, pages 114-119. Inconel contains approximately 80% Ni, 14% Cr, and 6% Fe, and is resistant to a wide variety of acid and alkaline corrosives. Mechanical and physical properties are tabulated, also the rates of corrosion in HCl, H_2SO_4 and HNO_3 solutions of various strengths. Hypochlorite solutions are less corrosive to Inconel than to Monel metal, though it should not be used in continuous contact with chlorine bleaching solutions of any strength. WHB (11a)

Commercial Production of Metallic Beryllium. EDGAR R. LARSEN. *Mining Congress Journal*, Vol. 21, Apr. 1935, pages 26, 35. A pilot plant with a daily production of 200 lb. of Be has been built in the U. S. Be-Al alloys for airplane construction show approximately twice the tensile strength for about ¾ the weight of steel. Be may be electroplated on Cu, Ni, Fe, Al and light metal alloys. By careful control of the temperature of the fused bath and by subsequent heat treatment the deposit will alloy with the base metal. Be bronzes possess very high strength and resistance to shock and fatigue. Alloys of Be with Ni, Cr, and Fe show high resistance to corrosion and excellent hardness, strength, and elasticity. Annealed Be steel resembles Si steel. Be is a good deoxidizer in the preparation of high conductivity Cu castings. BHS (11a)

The Influence of Impurities on the Properties of Lead. Part III. The Influence of Silver on the Rate of Recrystallization of Distorted Lead. R. S. Russell. *Proceedings Australasian Institute of Mining & Metallurgy*, No. 95, Sept. 30, 1934, pages 125-157. Pb containing less than 0.0005% total impurities was made by fire refining followed by electrolytic refining in an acid solution of Pb perchlorate and by casting in vacuum. The purest electrolytic Pb obtained, vacuum cast, vacuum annealed and then distorted 2½% recrystallized completely in 30 minutes at atmospheric temperature. Annealing in air delayed recrystallization a little, and aging at atmospheric temperature after air annealing delayed it a little more, but the maximum time of recrystallization was 2 hours. Casting in air hindered recrystallization, but not very much. An alloy with 0.0001% Ag added, cast in vacuum and annealed in vacuum and having uniform grain size, upon being distorted 5%, took 24 hours at atmospheric temperature to recrystallize; annealing in air extended the time to 29 hours. Electrolytic Pb of the same grain size treated the same way recrystallized in 5 minutes. Ag tended to enlarge and make less uniform the grain size. This delayed recrystallization still more,—1 sample taking 46 hours. A 0.0005% Ag alloy, after 5% distortion, took 64 days to recrystallize completely at atmospheric temperature; alloys containing 0.005 and 0.025% Ag, after the same distortion, had to be annealed 20 hours and 17 days, respectively, at 125° C. to produce complete recrystallization. AHE (11a)

Tin Base Bearing Metals. *Commonwealth Engineer*, Vol. 22, Feb. 1, 1935, page 222. Tests on Sn-base, Pb-base and alkali-Pb alloy bearings showed that there is no marked chemical reaction between the lubricant and the alloys except in the case of lubricants containing free fatty acid used with alloys high in Pb. The latter also exhibited higher frictional losses and wear than a Sn-base bearing alloy. An 80% Sn alloy ran quite satisfactorily at loads up to 2500 lbs./in.^{2} whereas the alkali-Pb alloy was unsuitable for more than 900 lbs./in.^{2} The strength of bearing alloys should not be excessive, because it is the very weakness that enables the metal to yield plastically and flow away from areas of high local pressure. Low melting alloys will melt and so prevent seizure in the event of undue temperature rises. Although failure by pounding is occasionally important, the outstanding present difficulty is a form of fatigue cracking in which pieces of the metal become loose. Remedies are (1) modification of design to reduce intensity of forces, (2) use of metals of superior fatigue resisting qualities. Increase of the Sb content in Sn-Sb bearing alloys improves notably the fatigue resistance. The same holds for Cd. WH (11a)

Effect of Composition on Mechanical Properties and Corrosion Resistance of Some Aluminum-alloy Die Castings. E. H. Dix, Jr. & J. J. Bowman. *Metals Technology*, Apr. 1935, *American Institute Mining & Metallurgical Engineers, Technical Publication* No. 616, 12 pages. Al-rich alloys containing Si, Cu & Si, and Cu, Si & Ni were studied. These contained various amounts of impurities such as Fe, Zn and Sn. Tensile specimens were exposed to steam and paraffin, a salt spray, and 5 different atmospheres. A group of 5 specimens was used for each exposure and a similar group was retained in the laboratory for determining the uncorroded properties. Plate specimens were also exposed and observed for surface attack. The 12% Si alloy had the highest resistance to corrosion. Al-Si alloys are definitely more corrosion resistant than alloys containing Cu. All common impurities except Fe in the 12% Si alloy adversely affect the corrosion resistance. Even with the maximum Fe content allowed by the A.S.T.M. specification Fe does not affect corrosion resistance. Small amounts of Ni and Zn do not affect mechanical properties of Si alloys. Cu increases strength and lowers elongation, Fe reduces elongation and if content is high reduces strength, while Sn lowers both strength and elongation. Very little growth occurred on holding at 100° C. for 100 days. JLG (11a)

On the Sorption of Hydrogen by Reduced Nickel. IV. On the Velocity of Sorption of Hydrogen at the Early Stages. Schun-ichiro Iijima. *Scientific Papers, Institute of Physical & Chemical Research, Tokyo*, Vol. 26, Jan. 1935, pages 45-69. In English. Pursuing previous research work (See *Metals & Alloys*, Vol. 5, July 1934, pages MA 354 L-1, MA 355 L-7) the experimenter studied the early stages of H sorption by Ni in order to prove the existence of the 2 different kinds of adsorption, viz. the van der Waals adsorption, followed by an activated adsorption or an adsorption of activated H which in turn is succeeded by a diffusion-controlled adsorption process. Based on tests at different temperatures and pressures, formulae covering the sorption velocities are derived and the mechanism of H sorption by reduced Ni is discussed. WH (11a)

Influence of Gas Ions on the Electro-Thermic Homogeneous Effect. C. Benedicks & C. W. Borgmann. *Arkiv för Matematik, Astronomi och Fysik*, Vol. 24, B, No. 10, 1934, 5 pages. In English. In determining the electro-thermic homogeneous effect in Pt, certain variations were observed which were found to be due to the presence of a gas (probably O) existing, at least partly, as ions. These ions cause a strong electro-thermic homogenous effect opposite to that of Pt and must possess a negative charge. The electro-thermic homogeneous effect caused by the gas ions may also be due, at least in part, to a true migration of O towards the positive end of the Pt wire. EF (11a)

Some Physical Properties of Platinum-Rhodium Alloys. J. S. Acken. *Bureau of Standards Journal of Research*, Vol. 12, Feb. 1934, pages 249-258. In continuation of the study at the Bureau of the metals of the Pt group, a series of Pt-Rh alloys containing approximately 10, 20, 40, 60, and 80% Rh was prepared from pure Pt and pure Rh. The melting point, hardness, density, electrical resistance, temperature coefficient of resistance, and thermal e.m.f. against Pt were determined for each alloy. The microstructure appeared to be that of a solid solution for all alloys. The particular qualifications of the alloys containing 20-40% of Rh, for use as resistance furnace windings for service at high temperatures are discussed. WAT (11a)

Standard Specifications for Free-Cutting Brass Rod for Use in Screw Machines. *American Society for Testing Materials Designation:* B 16-29; *American Standards Association*, A.S.A. No.: H8-1934, 3 pages. The specification covers chemical composition, physical properties, and permissible variations in dimensions. AHE (11a)

Standard Specifications for Copper Water Tube. *American Society for Testing Materials Designation:* B 88-33; *American Standards Association*, A.S.A. No.: H 23.1-1934, 5 pages. The specification covers chemical composition, physical properties, and permissible variations in dimensions. AHE (11a)

Some of the Alloys that Age Harden. Paul D. Merica. *Metal Progress*, Vol. 27, Mar. 1935, pages 46-50, 74. Interesting feature of the properties of duralumin and Al-Cu-Ni alloys, (Ni 68%, Cu 28%, Al 4%,) is excellent ductility in hardened condition. In precious metal alloys two distinct maxima in hardness are shown in Au-Ag-Cu-Pd alloys at 575° and 850° F. Excellent fatigue properties of Be-Cu are discussed and the hardening of Cu by nickel silicide and the use of Ni additions to bronzes to render them susceptible to aging. WLC (11a)

Electrochemical Properties of Germanium. J. Ivan Hall & Alfred E. Koenig. *Transactions Electrochemical Society*, Vol. 65, 1934, pages 215-219. Ge can be deposited electrolytically from strong aqueous KOH solutions of the dioxide. When coherent coatings of Ge are obtained, the under metal has no effect on the electrochemical behavior. Ge can be deposited from a molten electrolyte that will dissolve its dioxide. (11a)

Strength and Aging Characteristics of the Nickel Bronzes. E. M. Wise & J. T. Eash. *Transactions American Institute of Mining & Metallurgical Engineers*, Vol. 111, 1934, pages 218-244. Includes discussion. See *Metals & Alloys*, Vol. 5, May 1934, page MA 218. (11a)

Some Properties of Tin Containing Small Amounts of Aluminium, Manganese or Bismuth. D. Hanson & E. J. Sandford. *Journal Institute of Metals*, Vol. 56, Jan. 1935, pages 43-58 (Advance Copy No. 692). Al increases strength of Sn, but Sn containing Al deteriorates on standing in the atmosphere, the deterioration spreading from the surface inward. Rolled Sn-alloys deteriorate faster than cast alloys. A method for introducing Mn into Sn was devised. Very little Mn is soluble in Sn at any temperature and Mn has but a small influence on strength. What influence it has is brought about by grain refinement. Bi increases tensile strength of Sn from 1 ton/in.^{2} for the pure metal to 4.5 tons/in.^{2} for alloys with 4 to 5% Bi. Heat treatment has little influence on strength but alloys heated to near the eutectic temperature have low elongation. The tensile properties of Sn-Bi alloys support the Sn-Bi diagram given by Cowan, Hiers & Edward. Bi refines grains and prevents grain growth at elevated temperatures. 24 references. JLG (11a)

Characteristics of Modern Light Alloys for Mechanical Casting (Caratteristiche delle Odierne Leghe Leggere per Getti Meccanici). V. S. Prever. *Industria Meccanica*, Vol. 17, Feb. 1935, pages 91-97; Mar. 1935, pages 199-205. An exhaustive survey of light alloys, especially of ternary and quaternary alloys on a 4, 8 and 12% Cu basis is made. Curves of properties, tables of composition, change of properties with heat-treatment, equilibrium diagrams and microphotographs of structures are given. 13 references. Ha (11a)

11b. Ferrous

V. V. KENDALL, SECTION EDITOR

A New High Tensile Steel for Structural Work. Gilbert Roberts. *Structural Engineer*, Vol. 12, July 1934, pages 314-333; discussion, pages 333-338. Paper before the Institution of Structural Engineers, London, 1934, focusses attention on the "Chromador" steel containing .22 C, .8 Mn, .9 Cr, .3 Cu. In the U. S. A., Ni and Si steels have been extensively used for long span bridges and similar structures in which the saving in dead weight was of paramount importance. In small structures the use of these types of structural steel can only be economical if the percentage increase in strength is greater than the increased cost/ton. The speaker describes the properties and uses of Chromador which, in structures of moderate size, offer increase in strength of 50% at an extra cost of 15-20%. Test results compare the physical properties of the new steel with mild, Ni, Si, and the German structural steels ST 48 and ST 52. Supports the contention that the yield point rather than the ultimate strength is the true criterion of the usefulness of a structural seeel. Chromador has 37-43 tons/in.^{2} ultimate strength, 23 tons/in.^{2} minimum yield point, 17% elongation. Diagrams show elastic curves of Chromador vs. mild steel. The work hardening capacities (real stress in reduced area) of these 2 steels are identical, the former starting with an advantage that it retains. Bending tests on beams showed yield points of 24 and 15 tons/in.^{2} for Chromador and mild steel respectively. Further diagrams and tables present testing results under buckling (struts) and shearing loads (rivets). With the new steel the shear strength is approximately equal to the tensile strength before driving while for mild steel the ratio is .8-.9. The allowable working stresses adopted in various countries for different structural steels are fully discussed and suggestions are furnished for expressing the working stresses for high tensile steel. Comparative designs involving mild and Chromador steel are calculated through, proving the economical use of the latter (diagrams). F. M. Fuller pointed out the differing economic conditions in the U. S. A. and England. The lack of high tensile structural steels in which the modulus of elasticity increases in direct ratio to the higher yield point is deplored. High tensile steel rivets had less grip than mild steel ones and worked loose where reversal of stresses came into play. The permissible working stresses of mild steel have been gradually raised due to its absolutely uniform and reliable quality whereas the latest high-tensile structural steels are more or less in an experimental stage. J. S. Wilson states that mild steel withstands extraordinary deformation and punishment due to that tremendous extension beyond the elastic line at a reduced stress and that it has an extraordinary capacity to resist fatigue under severe conditions. H. J. Davey reports on test results showing that the advantage of Chromador over mild steel persists under the severe conditions of a high slenderness ratio. W. H. Woodcock found little difference between these 2 steels in laboratory corrosion tests. The speaker presented further data on fatigue and buckling tests in the discussion. WH (11b)

Notes on 29-9 Alloy Castings to Resist Heat & Corrosion. R. J. Wilcox. *Metal Progress*, Vol. 27, May 1935, pages 49-51, 66. Data are given on the physical properties, heat and corrosion resistance of 26-30% Cr, 8-14% Ni alloys. Corrosion resisting grade is supplied with 0.20% C and heat resisting with 0.60% C. The alloy has somewhat higher tensile and yield strength than 18-8 with lower ductility. It is more stable and heat treatment is not required to prevent intergranular corrosion. Additions of 2-4% Mo increase resistance to H_2SO_4. Si is not so effective in producing a free machining condition in 29-9 as in 18-8. WLC (11b)

Chromium Steels. RICHARD HENRY GREAVES. His Majesty's Stationery Office, London, 1935. Cloth, 6 x 9¾ inches, 321 pages. Price 7s. 6d.

Review of a technical publication is not merely a matter of reading; it is a much more involved undertaking, one that demands concentrated studies and a critical attitude of mind. The book by Dr. Greaves is a difficult one to review, because, although very valuable material is generously disseminated throughout most of its pages, it is—shall we say—hidden among old and well-known facts, the validity of some of which may justifiably be questioned. Lest this statement should be misinterpreted, it is to be pointed out that writing of a book such as Dr. Greaves has written always brings out the most pertinent and as yet undecided question: should or should not the author reprint in his book the data and information already known to exist and already reproduced in more than one publication? Dr. Greaves apparently arrived at a definite point of view, decided to make his book as complete as possible, and, unquestionably, succeeded most admirably. This is readily admitted by the present reviewer, who, however, as regards reprinting, holds to a different point of view. But since it is merely a question of personal opinion, it would seem much more fair to point out those chapters of pages in the book which are either new or summed up in a very skillful manner. Among such items must be mentioned the chapter on the "Constitution of the Chromium—Carbon Alloys" and "Chromium—Carbon—Iron Alloys," both chapters being the best existing summary of the subject. The critical attitude of the author toward the material described in these chapters is indeed very pleasing and helpful, and one might be so frank as to suggest that other chapters might be improved by the same attitude. The reference here is made in particular to Chap. 6 which contains a great deal of old and oft-quoted information: to be specific and to name only one, that of Arnold and Read published in 1911. In the same category of doubtful values may be placed some of the information reprinted from the book of Monypenny; again as an example, Table 53 on page 153 should be mentioned in which are reproduced results in obvious disagreement, yet the author offers no further information or explanatory remarks. This critical suggestion, however, must not be taken as indicating that the particular chapter has no value. On the contrary, it contains a great deal of important information such as that pertaining to fatigue and corrosion-fatigue or such important topics as Mechanical Properties of Chromium Steels at High Temperatures.

Two other important chapters which alone would fully justify the ownership of this book are Chaps. 7 and 8 dealing, Chap. 7, with Influence of Manganese and Silicon on Properties and Behavior of Chromium Steels, and Chap. 8, with Physical (not to be confused with mechanical) Properties of Chromium Steels. These 2 last-named chapters are not only instructive and important but are also well arranged and well written.

Dr. Greaves has done well, in our opinion, in confining his writings to straight chromium steels. His book is indeed a very valuable contribution to summarized knowledge of this important subject. Together with the book by Monypenny and another by the American Society for Metals it constitutes an indispensable item in any technical library.

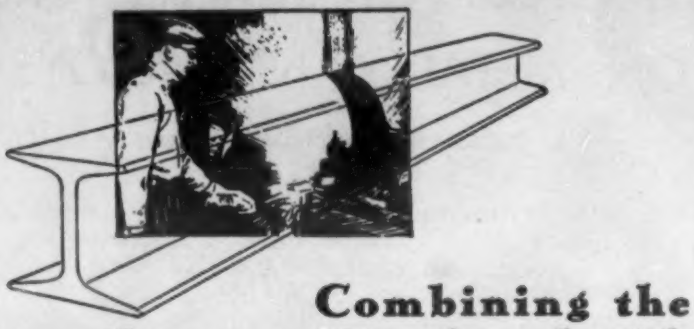
It is unfortunate that the valuable material and successful efforts on the part of Dr. Greaves are definitely marred by poor execution of curves. Some of the curves, as for example in Fig. 56 on page 107, are most difficult, if not impossible, to follow, while the selection of the scale and, in many cases, the absence of a ruled background, renders the reading of the curves most difficult. A critical reader of these lines should not, however, be alarmed by this frank criticism. Even without the figures and illustrations the book is a valuable document. V. N. Krivobok (11b) -B-

On the Properties of Cold Blast Charcoal Pig Iron. KAKUNOSUKE MIYASHITA. *Tetsu-to-Hagane*, Vol. 21, Jan. 25, 1935, pages 5-13. In Japanese. Various pig irons were melted in separate crucibles made of graphite and cast in dry sand molds from 1300°, 1400° and 1500° C. The relation between the tensile, bending and impact strengths and the melting conditions were studied. The microstructure and N contents of the specimens prepared were also studied. A cold blast charcoal pig iron melted at low temperature showed the pearlitic structure containing eutectic graphite, while at high temperature it showed cementite and flaky graphite structure. As to coke pig iron, the melting temperature had little effect on its structure which always contained large flaky graphite. The tensile strength of the coke pig iron more or less increased as melting temperature increased. A hot blast charcoal pig iron had intermediate properties. The cold blast charcoal pig iron melted in contact with air, had flaky graphite and large amount of cementite, but the coke pig iron did not. The N content of cold blast charcoal, hot blast charcoal, electric arc furnace, and coke pig irons were determined to be 0.008-0.0010%, 0.0012-0.0020%, 0.0015-0.0035%, and 0.0017-0.0025% resp. The strength of cast iron is almost inversely proportional to the N content. These facts show that the superior qualities of cold blast charcoal pig iron depend on its low N content. TS (11b)

An Investigation of Spring Steels. J. H. ANDREW & G. T. RICHARDSON. *Iron & Steel Institute*, May 1935, Advance Copy No. 2, 21 pages. Si-Mn, Cr-V and C steels were studied. Billets of Si-Mn steel were heated to different temperatures and rolled into plates. For a high heating temprature the decarburization was less than for a low temperature. The Si-Mn steel tended to decarburize more than the two other steels. The hardening properties were bettered by the higher rolling temperature. Better hardness resulted on quenching when the steel had been rolled with heavy reductions on each pass. A heavy tenacious scale on the steels tended to prevent proper hardening on quenching. Results of decarburization and hardness measurements indicated that the Cr-V steel was a better spring steel than the Si-Mn steel. Decarburization was measured by hardness and microscopically; the latter method did not indicate the true depth of decarburization. JLG (11b)

Low Alloy, Nickel Free Structural Steels (Schwachlegierte nickelfreie Baustähle). E. HOUDREMONT & H. KALLEN. *Technische Mitteilungen Krupp*, Vol. 2, Dec. 1934, pages 117-126. This comprehensive and detailed account of low alloy steels without Ni considers the properties obtained and the advantages and disadvantages of many steels, classified on the basis of partition of the alloying element between the ferrite and the carbide. Discusses the economic position of these steels compared to nickel-containing steels. MG (11b)

Notch Toughness of Cromansil Steel (Kerftaaiheid van Cromansilstaal). *Polytechnisch Weekblad*, Vol. 29, Jan. 10, 1935, pages 23-25. Reviews data presented by Hiemke & Schulte in an article on "Low Temperature Impact Tests of Medium Manganese Steel Plate" (see *Metals & Alloys*, Vol. 5, Feb. 1934, pages 31-36. WH (11b)



Low-Nickel Steel Proved Best for Low Temperature Equipment. R. K. HOPKINS. *National Petroleum News*, Vol. 26, Nov. 7, 1934, pages 64-71. To develop a steel suitable for the construction of an oil dewaxing plant operating at —40° F. tests were carried out on the following steels: (C) low C steel, max. .10 C; (S) silicon-killed C steel, max. .25 C; (M) .25 Mo steel; (N) 2.5 Ni steel; (NH) 3.5 Ni steel; and (V) .25 V steel. The steels were heat-treated at 1200° F. for 2, 6, 12, and 36 hrs., welded and the physical properties determined. Impact test data are given for +70°, —25°, and —50° F. for the weld, adjacent to the weld and the plate. Conclusions were as follows. The M, S or C plate, as-rolled and soaked, is not suitable for low temperature operation where shock is a factor, regardless of soaking time. Subsequent tests indicate that when Mo steel is properly made and treated, it shows considerable promise. Low-C and medium-C steels, however, are definitely not acceptable. The N plate is quite satisfactory for this service for any of the soaking times tested. The V and NH plates are also acceptable but neither shows as good results as the N plate. All of the welds tested (for at least one soaking time) are acceptable for service at —50° F., the preference being in the following order: V, M, S, C, NH and N. Grain size very decidedly affects the impact resistance at all temperatures. The smaller the grain the higher the impact resistance for any single steel tested. A predominance of large-grained ferrite seems to be detrimental to good low-temperature impact resistance, while a fine-grained well-dispersed pearlitic structure is distinctly beneficial. Chemical analysis contributes as much, or more, toward the control of impact resistance, than grain size. Ni and V each tend to produce good low-temperature impact resistance. The low-temperature impact resistance of the 3.5% Ni steel is no better than that of the 2.25% Ni steel. Prolonged soaking time at 1200° F. does not improve the low-temperature impact resistance of M, S, C or V steels. Prolonged soaking does improve low-temperature impact resistance of the N steel somewhat. This is also true for the NH steel, except in the case of 36 hr. specimen, which is lower than either of the other 3 specimens. The N and NH welds are improved by the increase in soaking time, but in no case is either of these welds as good as other welds tested. Brinell hardness does not change because of exposure to —50° F. for a period of 1 hr. The results of these tests indicate that the best welded structure would be obtained by welding the N plate with the M or V weld, but such a weld must be made and tested before a definite conclusion can be drawn as to the effectiveness of this procedure. VVK (11b)

Standard Specifications for Alloy-Steel Bolting Material for High-Temperature Service. *American Society for Testing Materials Designation*: A 96-33; *American Standards Association*, A.S.A. No.: G 17.2-1934, 6 pages. The specification covers heat treatment, chemical composition, physical properties, etc. AHE (11b)

Standard Specifications for Forged or Rolled Steel Pipe Flanges for High-Temperature Service. *American Society for Testing Materials Designation*: A 105-33; *American Standards Association*, A.S.A. No.: G 17.3-1934, 5 pages. The specification covers heat treatment, chemical composition, physical properties, etc. AHE (11b)

12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Thermal Expansion of Bearing Bronzes. PETER HIDNERT. *Bureau of Standards Journal of Research*, Vol. 12, Mar. 1934, pages 391-400; *Metal Industry*, London, Vol. 45, July 20, 1934, pages 57-60. Data are given on the linear thermal expansion of cast bearing bronzes Cu-Sn and Cu-Sn-Pb at various temperatures between 20° and 200° C. The coefficients of expansion obtained in the second test are generally higher than those obtained in the first tests. The addition of Sn to Cu, or Pb to Cu-Sn alloys increases the coefficients of expansion. Equations were derived which show the relationship between the Sn content and the coefficients of expansion of cast Cu-Sn alloys and between the Pb content and the coefficients of expansion of cast leaded bronzes with a Cu-Sn ratio equal to about 7. HBG + WAT (12)

Thermal Expansion of Columbium. PETER HIDNERT & H. S. KRIDER. *Bureau of Standards Journal of Research*, Vol. 11, Aug. 1933, pages 279-284. The linear thermal expansion of a rod of Cb containing 0.93% Sn and 0.26% Fe is given. Data were obtained at various temperatures between —135° and +305° C. The coefficient of expansion increases regularly with temperature. From 0° to 100° C. the average coefficient of expansion is 7.2×10^{-6} per ° C. WAT (12)

Thermal Conductivity of Some Irons and Steels Over the Temperature Range 100° to 500° C. S. M. SHELTON. *Bureau of Standards Journal of Research*, Vol. 12, Apr. 1934, pages 441-450. The thermal conductivities over the range 100°-500° C. have been determined for 20 irons and steels which were selected as typical of commercial materials used for a variety of purposes and expected to have considerably different thermal conductivities. The data on the Cr-Fe and Cr-Ni-Fe alloys are of particular interest because of the lack of previous data on the thermal conductivity of stainless steels. The results indicate that the differences in conductivity of irons and steels are much smaller at high temperatures than at room temperatures. High-alloy steels have lower thermal conductivities than low-alloy steels. The conductivities of irons and low-alloys steels decrease with increasing temperatures. The conductivities of the high-alloy steels increase with an increase in temperature; in other words, an increase in the amount of alloying elements in Fe causes, in general, a decrease in thermal conductivity and an increase in the temperature coefficient. The many and sometimes conflicting factors concerned make it practically impossible to generalize on the quantitative relationship of thermal conductivity and total alloy content of ferrous metals. A fairly complete bibliography of data on the thermal conductivity of Fe and steels is given. WAT (12)

Resistance of Cast Iron to High Temperatures. Influence of Silicon and Aluminum. M. H. THYSSEN. *Foundry Trade Journal*, Vol. 51, Sept. 20, 1934, page 184. Paper read at the autumn meeting of the Iron & Steel Institute. See "Influence of Silicon and Aluminum on the Resistance of Cast Iron to High Temperatures," *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 584. CEJ (12)

Behavior of Metals at Elevated Temperatures. H. DUSTIN. *Heat Treating & Forging*, Vol. 21, Jan. 1935, pages 29-30, 34; Feb. 1935, pages 83-84, 99. Paper read before the Iron & Steel Institute. See "Belgian Research Committee on the Behavior of Metals at Elevated Temperatures," *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 584. MS (12)

Superheat Destroys Crystal Nuclei. H. PESSL. *Metal Progress*, Vol. 27, May 1935, pages 61-62. Superheating of molten metals decreases the number of nuclei for crystal formation. Al, Sb and Cu showed substantial increases in grain size with increased superheat. WLC (12)

Application of Pearlitic Alloy Steels to Specific Refinery Problems. A. E. WHITE, C. L. CLARK & R. L. WILSON. *National Petroleum News*, Vol. 26, Nov. 7, 1934, pages 31-39. The steels tested were: (DM) .07% C, .72 Si, 1.24 Cr, .54 Mo; (4-6 Cr-Mo) .10 C, 5.09 Cr, .55 Mo; (C-Mo) .16 C, .42 Mo; (MM9) .15 C, 1.25 Mn, .25 Mo; (4615) .14 C, .25 Mo, 1.85 Ni; and a plain .15 C steel. Data for all steels in the form of tables and curves are given for ultimate strength, yield strength, proportional limit, elongation, reduction of area from 85° to 1400° F; creep strength from 800° to 1300° F.; Izod impact under stress for 500 to 1590 hrs. from 85° to 1200° F; Charpy impact from 80° to 1200° F. after holding at temperature one and 1000 hrs.; and oxidation resistance at 1000°, 1250° and 1500° F. Applications of these steels were given as follows. MM9 steel, normalized and tempered, is intended for service and temperatures up to 1000° F. wherever greatest short-time and creep strength are required, especially in high temperature steam service. 4615 steel which has lower creep strength than MM9 steel also qualifies for high temperature steam service up to 1000° F. This steel would be preferred to the MM9 steel in corrosion and oxidation resistance. C-Mo steel is used mainly for still tubes in oil refining. This alloy exhibits good creep strength and structural stability up to 1100° F. although it does not resist oil corrosion and oxidation any better than plain carbon steel. DM steel has the highest creep strength of the group of alloys described, is quite stable up to 1200° F. and lasts 2 to 3 times as long as C steel in cracking furnace tubes. There is also the possibility that the range of working temperatures of DM and C-Mo steel can be extended higher by means of calorizing. The 4-6 Cr-Mo steel is the low-alloy composition most resistant to oxidation and corrosion by petroleum products. In addition, the steel is stable up to 1200° F. and maintains good mechanical properties up to 1100° F. The principal applications have been still tubes, heat exchanger tubes and hot oil piping. VVK (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

Third Report of the Corrosion Committee. Joint Committee of the Iron & Steel Institute & the British Iron & Steel Federation. *Iron & Steel Institute, Special Report* No. 8, May 1935, 214 pages. Section A is an introduction giving the organization of the Committee and an outline of the work. Section B, by J. C. HUDSON, is a detailed report of the Committee's field tests on atmospheric corrosion. Observations of painted and uncoated specimens of mild steels and irons exposed at different stations are given. Several high-tensile structural steels were recently made and exposed. Section C is on Marine Corrosion. Part 2, by J. C. HUDSON, describes the behavior of specially prepared plates installed in a barge. Part 3, by R. H. MYERS, is a report of the examination of some pontoons that had been found to be badly pitted. It was concluded that the interval of 7 years between successive reconditioning of the protective coating was too long. Welds were made on the pontoons and their behavior will be reported. Part 4 gives results of tests on corrosion of welded ships' plates. Tests indicated that welding did not increase danger of corrosion. Section D contains results of laboratory studies. Part 2, by R. B. MEARS, deals with the probability of corrosion as determined by the "drop" method. In this method drops of the corrosive liquid are placed on the specimen and the number causing rust in a given time observed. For scale-covered samples it was found that probability of corrosion is largely governed by the physical characteristics of the scale. Part 3, by G. D. BENGOUGH & F. WORMWELL, contains the results of closely controlled corrosion tests in salt solutions and water. Both O absorption and H evolution were determined. Tests extended for periods up to 3.5 years. The rate during a particular stage of corrosion rather than the actual corrosion during a period beginning with a fresh specimen is significant for evaluating materials. Standardized methods for carrying out immersion tests are recommended. Part 4, by K. G. LEWIS & U. R. EVANS, deals with the effect of mill scale on the rising of paint. Exposure tests indicated that specimens from which the scale had been partly removed by weathering behaved much worse than those that were wholly scale covered or wholly descaled. Part 5, by K. G. LEWIS & U. R. EVANS, gives results of 2.5 years atmospheric exposure in 3 different localities of 10 different materials, both uncoated and painted. Part 6, by J. C. HUDSON, tells of the exposure of some wires to the atmosphere. Part 7, by J. C. HUDSON, contains results of tests on the aging of mild steel wire. Some wires showed an increase in strength on aging and others no change, the behavior varying with the degree of cold work. Part 7, by J. C. HUDSON, gives the results of some tests on painted specimens exposed at 2 different ocalities. Specimens pickled before painting behaved the best. Section E, Part 1 gives the results of examination of some mine ties. The ties examined had not corroded badly. Part 2 reports briefly on the examination of an old wrought-iron rail and a cast-iron bridge. The bridge was built in 1779 and was said to be the first cast-iron bridge ever built. JLG (13)

Corrosion Problems. JOHN JOHNSTON. *Industrial & Engineering Chemistry*, Vol. 26, Dec. 1934, pages 1238-1244. The theory of corrosion is considered from a thermodynamic standpoint. A substance can corrode in a given environment only in so far as it can react with some constituent of that environment; if such reaction is inherently impossible under the conditions, there can be no corrosion. Therefore two substances tend to react spontaneously so long, and only so long, as the reaction is accompanied by a decrease in the free energy of the system. The initial state of the system must be less stable (or less probable statistically) than the final state. The difference in energy between the initial and final state of the system is a direct measure of the "driving force" of the reaction no matter how we happen to observe it whether by measuring the electrochemical potential or by other means. Whether a substance is really stable or not—that is, does not or does tend to corrode—depends therefore not only upon its own inherent properties, but also upon the precise environment to which it is exposed. The other dominant factor is the rate of reaction. This cannot be predicted; it can be ascertained only by trial under precise and specific conditions, and an almost imperceptible change in conditions may affect the rate enormously. The production of a film or skin at the surface of the metal may slow down the rate of reaction to a negligible value. At present, a study of the conditions of film formation, the characteristics, composition, etc. of the films formed offer the most promising field from a practical standpoint. This is discussed in considerable detail. VVK (13)

Wear of Iron Alloys on Emery Paper and Their Hardness (Verschleiss von Eisenlegierungen auf Schmirgelpapier und ihre Härte). W. TONN. *Archiv für das Eisenhüttenwesen*, Vol. 8, Apr. 1935, pages 467-470. A machine for wear testing on emery paper is described. With proper precautions the values obtained were reproducible. Inequalities in the same grade of papers could be detected by means of duplicate tests. In C steels comparable results were obtained in wear tests in the Spindel machine and on the emery paper as well as by scratch hardness tests. SE (13)

Some Good Jobs Around a Refinery. H. R. LELAND. *Metallizer*, Vol. 3, Feb. 28, 1935, pages 4, 5. Descriptions are given of the use of metal spraying at oil refineries for coating head exchanger baffles, surge pots, pump shafts and plungers, valve bodies, ball floats, radiant tube headers and radiant tubes for corrosion resistance and to rebuild worn or corroded parts. Al, Sn, Ni, bronze, Monel metal and stainless steel were used for this type of work. Large boxings for babbitt lined bearings which are difficult to retin were sand blasted, tinned by metal spraying and lined with babbitt successfully. A broken water jacket of an engine block was readily repaired by filling the voids with sprayed Cu. BWG (13)

Cylinder Wear Measured by Iron Content of Oil as Determined by the Colorimeter. GEORGE H. KELLER. *Automotive Industries*, Vol. 72, Apr. 6, 1935, pages 484-485. Rate of cylinder wear may be determined during the test as well as the total wear by taking samples at definite time intervals. About 10 g. of the oil is burned to an ash which is dissolved in 18 N HCl. This solution is analyzed colorimetrically by the sulfocyanide method. BWG (13)

Corrosion and Uses of Metals (La corrosion et l'emploi des métaux). ALBERT PORTEVIN. *Aciers Spéciaux, Métaux et Alliages,* Vol. 9, Oct. 1934, pages 287-290. Introductory paper to the technical study of corrosion. GTM (13)

Causes of Failure and Methods of Preservation of Condenser Tubes. H. C. DINGER. *Marine Engineering & Shipping Age,* Vol. 11, Mar. 1935, pages 96-98. The application of Admiralty metal, Monel metal, Cu-Ni alloys, stainless steel or iron, and plated tubes as condenser tube material is discussed. Dealing with the causes of failure the author discusses defects in manufacture and installation, the hydro-dynamic effect of circulating water, the electrolytic phenomena, and the effect of air in the water. Kz (13)

Periodic Potential Fluctuations of Iron in Nitric Acid (Über die Potentialschwingungen des Eisens in Salpetersäure. I). M. KARSHULIN. *Zeitschrift für Elektrochemie,* Vol. 41, Apr. 1935, pages 224-229. Potential-time measurements were made on Fe partially and fully immersed in HNO_3 of various concentrations. A strip of Armco Fe dipped into 65.85% HNO_3 gave a potential of +1.07 volts in a short time which remained constant at this value with temperature maintained at 20° C. An increase in temperature to 50° C. decreased the potential to +.90 volts and periodic fluctuations began to take place. The same type of potential fluctuation could be obtained by immersing Fe in HNO_3 with concentrations down to 41.8%. If the Fe is scratched with a glass rod while totally immersed in HNO_3 with concentrations down to 59% the Fe becomes brown locally and the potential decreases rapidly to more negative values. In HNO_3 with concentrations of 57% or less if the immersed Fe is scratched with a glass rod the entire Fe surface becomes brown and the potential again drops rapidly to more negative values. After a few seconds this film disappears while gas is evolved from the Fe and streaks appear on the surface. This may be repeated indefinitely simply by scratching the Fe surface. Many other cases of potential fluctuation are reported for other concentrations of HNO_3 and the curves shown for the periodic type of fluctuation indicate that the periodicity and the range of the fluctuation are characteristic of definite concentrations of HNO_3 and of how the Fe is immersed. Motion pictures of the Fe fully immersed in HNO_3 and undergoing the periodic potential fluctuation are shown. The indications are that the Fe becomes covered with a dark, reddish brown film and this film is disturbed at regular intervals by a gas evolution of explosive character, the gas being evolved alternately at sharp boundaries of the Fe strip. During the short interval of gas evolution the potential increases to a more positive value and in the following interval when the film again covers the Fe the less noble potential manifests itself. To explain this behaviour the author cites numerous literature references with respect to HNO_3. The formation of complex, dark colored compounds are assumed from a review of the literature, the compounds representing a combination of adsorption of NO and Fe salts. These compounds are sensitive to temperature change and decompose easily with reformation of NO and the Fe salt. The explosive evolution of gas as found by the author is considered to be connected with such a decomposition and the change in potential is associated with a change in concentration of the ferric ions: The author's opinion is that the periodic fluctuation of potential of Fe when immersed in HNO_3 is due to the periodic building up of a passive film on the Fe and the dissolution of the film. WB (13)

Corrosion Examples from Practice, Their Causes and Preventions (Korrosionsbeispiele aus der Praxis, ihre Ursachen und Vermeidung). KARL MANDL. *Mitteilungen des Technischen Versuchsamtes, Wien,* Vol. 33, 1934, pages 41-46. Mild steel plates were corroded by formation of local elements of slime and metal; razor blades by attack of the enveloping paper; boiler plates became caustic brittle by feed water too high in soda. Zn sheets were destroyed resting on wet brickwork whereby condensation water which formed on the inside dissolved sodium sulphate from the bricks and again local elements gave rise to corrosion. In a similar way, lead pipes which were laid in a wet wall were destroyed. Ha (13)

Profitable Machine Shop Jobs. ROY SOFIELD. *Metallizer,* Vol. 3, Feb. 28, 1935, page 9. Applications are cited of metal spraying in machine shop practice. BWG (13)

Cylinder Liners. T. R. TWIGGER. *Automobile Engineer,* Vol. 25, May 1935, pages 179-181. Tests on automotive vehicles which are operated under constant stopping and starting conditions where the cylinders never attain the normal temperature showed that the increased wear under these conditions can be greatly improved by using centrifugally cast iron cylinder liners and piston rings of austenitic structure. Ha (13)

Metallizing Process in Canada. R. J. MCWATERS. *Metallizer,* Vol. 3, Feb. 28, 1935, pages 6-7, 10. The development, history, apparatus and procedure in metal spraying are reviewed and a number of important applications in the fields of corrosion, erosion, abrasion and decoration are cited. Rebuilding worn, corroded or undersized parts is an especially useful service. Advantages are given of spraying babbitt linings in bearings to secure thin, sound, adherent linings without the necessity for tinning. BWG (13)

Corrosion Protection in Artificial Silk Industry (Korrosionschutz in der Kunstseidefabrikation). FRITZ OHL. *Die Kunstseide,* Vol. 17, Apr. 1935, pages 142-145. General review of non-metallic coatings for corrosion protection. The special corrosion conditions prevailing in artificial silk manufacture are only touched upon. EF (13)

The Diffusion of Hydrogen Through Mild Steel Sheet During Acid Corrosion. T. N. NORRIS. *Journal Society of Chemical Industry,* Vol. 54, Jan. 18, 1935, pages 7T-13T. Liberated H in acid corrosion diffuses through the metal, and is liberated on the side of the metal not in direct contact with the acid. Author builds on the present knowledge of H diffusion by a series of well designed experiments. The investigation was limited to H diffusion occurring with (a) mild steel sheet in the "white annealed" condition, i.e., in the stage just before tinning, (b) tinned mild steel sheet, and (c) lacquered mild steel. The acid used for corrosion was a 1% solution of citric acid, either plain or with the addition of various corrosion inhibitors, known to affect the speed of reaction. It was found that a tin coating on the side of the sheet not in contact with the acid retarded H diffusion, not completely however, due to discontinuities in the tin coating. Oxide films act as complete or partial barriers to diffusion. Lacquer coatings have no retardation effects. Numerous tables of experimental data and H-diffusion graphs. 6 references. AAA (13)

Development of Alloy Steels for Oil Refinery Service. W. H. Wiewel & R. L. Wilson. *National Petroleum News,* Vol. 26, Aug. 1, 1934, pages 17-22. Comprehensive review of the development and properties of Cr and Cr-Ni (18-8) alloys for oil refinery service. The following observations are based on a tabulation of operation records from a number of alloy tube installations. 4-6% Cr steel tubes corrode 1/5 to 1/9 as fast as C steel tubes. Corrosion resistance of
1 4-6% Cr is not apparently affected by C content. Specimens of used tubes of 4-6% Cr regardless of C content show some embrittlement at room temperature. The addition of 0.5% Mo inhibits this embrittlement in 4-6% Cr tubes. KA2S tubes are subject to temper embrittlement as low as 900° F. Apparently a Cr content of about 5% affords slightly better corrosion resistance than when Cr is less than 4.75%. 4-6% Cr tubes swell before failing in operation. KA2S tubes fail without warning. The 5% Cr steel containing .5% Mo appears to be outstanding from the standpoint of corrosion resistance and high strength at
2 elevated temperatures combined with low price. VVK (13)

Corrosion of Magnesium (Die Korrosion von Magnesium). L. Whitby. *Korrosion & Metallschutz,* Vol. 11, Apr. 1935, pages 88-89; discussion by W. Kroenig & S. Pawlow, Apr. 1935, page 89. Exchange of views on the protective film formed on Mg and Mg alloys and particularly on the Mn addition to Mg which is considered essential for the formation of a corrosion-resisting film. 8 references. Ha (13)

A Special Corrosion Case and Its Investigation (Ein Fall von Korrosion und seine Untersuchung). K. Weisselberg. *Petroleum,* Vol. 31, Mar. 6, 1935,
3 pages 7-8. Corrosion defects caused the breakdown of stills for the distillation of Rumanian crude oil. The defects are ascribed to the action of S. The following test indicated the occurrence of S inclusions. A bromine gelatine paper is soaked in an acid sublimate solution and pressed against the degreased steel sample under test. After 2-3 min., the paper is washed in water, dried and submitted to a drop test with iodazide. Gas bubbles of nitrogen indicate the presence of S. If one wants to avoid expensive corrosion resistant structural materials, the best means of counteracting the corrosive action of H_2S, are neutralizing agents such as NH_3, soda, and lime. The latter is very cheap and was found to cut down corrosion by one half according to Egloff (*Oil & Gas Journal,* Vol. 26, 1927,
4 page 80). The chemical effect of lime on the oil products handled is discussed. EF (13)

Effect of Heat Treatment on Corrosion Resistance of Magnesium-Zinc and Magnesium-Aluminum Alloys. Takejiro Murakami & Susumu Morioka. *Iron Age,* Vol. 135, June 6, 1935, pages 10-11, 46, 48, 50. Abstract of paper appearing in Science Reports of Tohoku Imperial University. See *Metals & Alloys,* Vol. 6, Feb. 1935, page MA 74. VSP (13)

Corrosion Resistance of Condenser Tubes Made of Different Alloys in Relation to Brinell Hardness (Die Korrosionsfestigkeit der Kondensatorrohre verschiedener Legier-
5 **ungen in Abhängigkeit von der Brinellhärte).** Aug. Siegel. *Die Wärme,* Vol. 58, Mar. 16, 1935, pages 173-177. Observations over a long period of time proved that unusually rapid corrosion of ferrous and non-ferrous materials in ships and power plants are attributable to eddy currents. The author states that "metals utilized as structural materials are attacked due to electrolysis; hence the alloy itself does not exert any influence upon the corrosion resistance other than its hardness." (A scientific interpretation of this phenomenon is not furnished but it is said to be the result of several years' experience). Two test set-ups are reproduced which were designed for determination of corrosion defects due to
6 galvanic action. EF (13)

New Bearing Alloys and Tendency Toward Blended Oils Bring New Problems of Engine Lubrication. *Automotive Industries,* Vol. 72, Apr. 13, 1935, pages 510-512. The new bearing alloys, as Cd-Ag and high Pb-Cu, are said to be essential to the performance of modern engines, especially heavy duty engines. Compounded oils may be necessary, at least in aircraft engines, but great care must be taken in selecting the right lubricant. Use of Adher-O-Scope for measuring the adhesion of oil and the construction and test results of the Lubarometer are described. BWG (13)

7 **Rust-Proofing Iron and Steel Products Before Finishing Them.** *Industrial Finishing,* Vol. 10, Nov. 1934, pages 22, 24-26. A brief description of the Parkerizing, Parcolite spraying and Bonderizing processes as used for protecting iron and steel surfaces from the action of rust. JN (13)

Determination of the Corrosion Rate by Electrical Means (Festellung der Korrosionsgeschwindigkeit auf elektrischem Wege). *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Aug. 15, 1934, pages 359-360. Discussion of Tödt's corosimeter and its utilization. EF (13)

8 **Improved Machine Element Repairs.** *Metallizer,* Vol. 3, May 10, 1935, pages 8-9. Illustrations and descriptions are given of the use of metal spray equipment for repairing and coating automotive and other machine elements. BWG (13)

Rust Protection and Rust Inhibiting Agents in the Light of the Present Raw Material Situation (Rostschutz und Rostschutzmittel unter dem Zeichen der gegenwärtigen Rohstoffverhältnisse). *Die Metallbörse,* Vol. 25, Jan. 26, 1935, pages 98-99. Critical discussion on the present state of non-metallic coatings applied to ferrous materials. EF (13)

Zinc as Adequate Rust Protection (Zink als vollwertiges Rostschutzmittel).
9 *Metallwaren-Industrie & Galvano-Technik,* Vol. 32, Oct. 1, 1934, pages 432-433. Electro-chemical behavior of Zn on Fe under corroding conditions discussed. EF (13)

Inside Corrosion of Tanks for Liquid Fuel (Zerstörungen im Innern von Treibstoffbehälter). *Die Wärme,* Vol. 58, Mar. 9, 1935, pages 160-161. Brass, Zn and Pb coated fuel tanks corroded, while Sn coated ones exhibited remarkable corrosion resistance. An accelerated attack due to electrolytic action was noticed
10 at those spots where water accumulated. More pronounced corrosion has occurred since the German laws prescribed an addition of 10-12% alcohol. Experiments of the Reichskraftspritgesellschaft disclosed that Pb and Zn are unsuited in contact with German motor fuels. Up to 20% alcohol, no loss of strength was observed on Al and its alloys. Light metal alloys are particularly suited when provided with an artificial surface treatment. EF (13)

Corrosion of Iron and Steel. Metallizing the Only Solution. J. H. Hishon. *Metallizer,* Vol. 3, May 10, 1935, pages 2-3, 13. Theories of the corrosion of Fe and means for preventing corrosion are reviewed. By spraying Zn, an effective controlled coating of any thickness may be applied without regard to the size and location of the structure. BWG (13)

Corrosion of Marine Structures. F. Grimshaw Martin. *Metal Progress,* Vol. 27, May 1935, pages 55-56. The only preventive for ship plate corrosion is paint as the sea water resistant steels are too costly. WLC (13)

Corrosion Research. G. W. Molle. *Electrical Review,* Vol. 116, Apr. 12, 1935, page 545. Gives some general observations on corrosion prevention and outlines methods of bonderizing and Parkerizing. Be-Cu should have some future for overhead line conductors because of its high strength and great resistance to corrosion. Author made qualitative tests on conductors by placing together samples of plain hard-drawn Cu, Cu-cored steel, steel-cored Cu, stranded Al, and galvanized and tarred stranded steel in a glass jar, half-filled with a strong solution of NaCl, which was allowed to evaporate under normal conditions of sun and air. Jar was left dry for a while, then the process was repeated. After 3 years none of the Cu conductors and no galvanized core were corroded. Al disappeared within 2 months. Concludes that, if properly galvanized and well tarred, a stranded-steel conductor can be erected with perfect safety in any salty atmosphere. MS (13)

Oxidation Resistant Steels (Les aciers inoxydables). André Michel. *Aciers speciaux, Métaux et Alliages,* Vol. 9, Oct. 1934, pages 331-339. In annealed condition a 13% steel has a chromium ferrite structure and globular complex carbides. This heterogeneous structure renders the steel somewhat resistant to oxidation. In order that this steel should be resistant to oxidation the Cr content must be: Cr = 11 + 18 C. The maximum carbon solubility in Cr steels is given as follows:

Cr = 11%	C = 0.80
13%	0.65
15%	0.55
17%	0.40

For a 11% Cr steel a complete carbon solubility is obtained at:

C = 0.3%	950° C
0.4	1075° C
0.6	1150° C
0.8	1200° C

A maximum Brinell hardness of 610 is obtained on a steel containing 0.35-0.40% C, 13% Cr and oil quenched from 1030° C. Low carbon 16-18% Cr steel resists nitric acid solutions. An addition of 1% Cu to this steel improves its corrosion resistance to certain acids. A steel with 2% Ni, 17% Cr is more resistant to severe atmospheric conditions than a 13% Cr steel. Steel with 25-30% Cr is used to resist high temperature oxidation. Long heating at 500° C. renders this steel brittle. Ti and Cb are added in order to improve ductility and forgeability, and chromium nitride for reducing the grain size. Adding large amounts of Ni to Cr steels produces austenitic steels of which the composition is C less than 0.4%, Cr 12-25%, and Ni 7-35%. The austenitic Cr-Ni steel resists organic and inorganic acids, bases and salt solutions. Addition of 3% Mo to an 18-8 steel increases the resistance to SO_2 at elevated temperatures, to H_2SO_4, acetic and formic acids. Addition of 4% raises the resistance of this steel to NH_4Cl, HCl, H_2SO_4. GTM (13)

34th Report of the Joint Research Commission of the Institution and Leeds University. Corrosion from Products of Combustion of Gas. Part II. Tube Experiments. James W. Wood & E. Parrish. *Gas Journal,* Vol. 208, Oct. 31, 1934, pages 356-357. Tests made on metal tubes to determine the effect of the products of gas combustion were made at 40°-60° F., whereby 80-95% of the water produced by the combustion of the gas was condensed together with the acids of S and N dissolved therein, forming the corroding medium. Tests on Cu, soft and hard, on Ni plate, brass, Cr plate, and Al, as well as Fe, Zn, and galvanized Fe were made. They showed that the use of Pb and Sn and solder is justified. Zn, black Fe and galvanized Fe are unsuitable. Tests on Cr and Ni plate were not conclusive. MAB (13)

Use of Graphite to Prevent Formation of Boiler Scale (Graphitverwendung zur Kesselsteinverhütung). Freitag. *Oberflächentechnik,* Vol. 12, May 21, 1935, page 123. Additions of finest colloidal graphite to the boiler water prevents formation of a firmly adhering boiler scale. Due to the surface action the salts are precipitated as slime which collects on the bottom of the boiler and can easily be removed. The effect is a purely physical one without chemical reaction. Ha (13)

Corrosion and Corrosion Protection with Special Reference to Boiler Plants (Korrosion und Korrosionsschutz unter besonderer Berücksichtigung der Dampfkesselbetriebe). G. Frantz. *Die Wärme,* Vol. 58, Feb. 23, 1935, pages 109-115. This review discusses the subject under the following heads: corrosion research and testing, material and design, corrosion resistance of welds, scaling due to effect of flame and combustion gases, scaling of superheater tubes due to effect of steam, chemical attack of pure H_2O on Fe, corrosion due to gas content in boiler water, steam dissociation, free acid and other ingredients, corrosion due to electrolysis and protection against this, external rusting of boilers, corrosion fatigue, caustic embrittlement, boiler incrustations as corrosion-promoting agent and protection, corrosion prevention by deaeration of feed water, protection by chemical means, coatings, maintenance of idling boilers, attack of lyes and salts at extreme boiler pressures and temperatures. EF (13)

Role of Copper in Protection of Buildings from Humidity and other Exterior Agents of Deterioration (Le role du Cuivre dans la Protection des Immeubles contre l'Humidité et les Agents extérieurs de Dégradation). M. Gossieaux. *Cuivre et Laiton,* Vol. 8, May 15, 1935, pages 203-205. Protection by Cu sheeting in foundations, walls and roofs, and the manner of laying it and connecting it with the structure are described. Ha (13)

Notes on Aluminum Alloys Exposed to Sea Water. F. Giolitti. *Metal Progress,* Vol. 27, May 1935, pages 62, 78. Al alloy for sea water resistance used in Italy has composition Mg 2.0%, Mn 1.3%, Sb 0.2%, Si 0.6%, Fe + Ti 0.25% which shows a loss in weight due to corrosion by active NaCl solution of 0.1 to 0.2 g./100 cm.² of surface in 24 hrs. WLC (13)

Protection from Corrosion in Hot-water Supply and Heating Installations (Korrosionsschutz bei Warmwasserversorgungs- und Heizungsanlagen). E. NAUMANN. *Zeitschrift Verein deutscher Ingenieure,* Vol. 79, May 4, 1935, pages 545-546. Conditions contributing to corrosion in such plants and the means to eliminate or mitigate them are reviewed. Treatment of water, reduction of pressure, freedom from air of the water are the principal points. Low pressure water heat- 1
ing plants are decidedly preferable. Treatment of water with phosphate or sulphite according to local conditions is advisable. Ha (13)

Boiler Steel Embrittlement. E. P. PARTRIDGE & W. C. SCHROEDER. *Mechanical Engineering,* Vol. 57, May 1935, pages 294-296. A critical summary of information published so far on cracking of boiler plates due to caustic embrittlement. The chemical factors in the attack of boiler water on steels, especially low C steels and the mechanism of embrittlement failure are discussed. The prevention of the latter phenomenon, in as far as it can be controlled by water conditions, depends primarily on maintaining a stable, self-repairing coat of oxide on 2
the steel which effectively separates the steel from contact with the water. Further research is suggested. Ha (13)

The Intercrystalline Corrosion Phenomenon as Observed in Certain Chromium-Nickel Corrosion-Resisting Steels. W. H. HATFIELD. *Metal Treatmnt,* Vol. 1, Spring 1935, pages 30-32. Plain 18-8 Cr-Ni steels become extremely susceptible to intercrystalline attack after certain heat treatments. A standard test for this condition consists in boiling in a $CuSO_4$-H_2SO_4 solution for 65 hours. Sensitivity to attack is increased by heating to 500°-750° C., but can be destroyed by very prolonged heating at these temperatures (1500 hours at 650° C.) or by a short treatment at 800°-950° C. Steels very low in C or containing W, Ti, or 3
both are not susceptible to attack, which is generally ascribed to chromium impoverishment at grain boundaries resulting from precipitation of chromium carbides. JCC (13)

Underground Corrosion in the Southeastern United States. K. H. LOGAN. *Journal American Water Works Association,* Vol. 27, Apr. 1935, pages 419-434, discussion pages 434-438. As a national problem, underground corrosion results in losses which justify a serious attempt to reduce them. The seriousness of the problem with respect to an isolated pipe system or network depends largely on the soils to which the pipes are exposed. One of the fundamental and principal 4
causes of underground corrosion appears to be an uneven distribution of oxygen at or near the pipe surface. Soil corrosion appears to be accelerated by increase in temperature, hence, on the average, soil corrosion would appear to be more serious in the southern states which is confirmed by experience. Rainfall accelerates corrosion. Acid soils may accelerate corrosion not because of the dilute acids present but by the retardation of the precipitation of corrosion products which under favorable circumstances reduce rates of corrosion. In arid and semiarid regions of the southwest where rainfall is not sufficient to remove the soluble salts from the soil, the electrical conductivity of the soils indicate in a general way their corrosiveness. The performances of different ferrous materials do not 5
differ sufficiently to permit any one of them to be proved superior by the data now available. Penetration-time curves show a decrease in rate of corrosion with time which can be due to the deposition of products of corrosion either in the soil surrounding the metal or on the surface of the metal and the settling of the soil surrounding the pipe. The idea that the depreciation of a pipe line is proportional to its age is incorrect. Several methods of protecting pipes are available which appear to be better than those used in the past, but data on their effectiveness are insufficient to place the design of protection for a pipe line on an engineering basis. A plea for cooperation in the accumulation of data is made. VVK (13) 6

Action of Sulphur on Certain Metals (Action du Soufre sur Certains Métaux). RÉNÉ DUBRISAY. *Chimie et Industrie,* Vol. 29, Special Number, June 1933, pages 631-632. The blackening of Cu or Ag by S and its compounds is well known. The author has studied the mechanics of this action and concludes that it may be produced by S itself in the interval of the reaction at each S combination. Infinitesimal quantities of S (millionth of a milligram) have a marked effect on Ag plate. MAB (13)

Reduction of Production Corrosion Losses Due to Selection of Equipment. 7
WALTER F. ROGERS. *Oil & Gas Journal,* Vol. 33, Apr. 4, 1935, pages 84-86. The production of oil together with the accompanying gas and brine oftentimes results in rapid corrosion of the equipment used. The corrosiveness of the fluid from a new field is generally determined by the presence or absence of H_2S. Surface equipment is generally more subject to rapid attack from H_2S than is the subsurface equipment due to the fact that the fluid as produced is free from oxygen which factor first enters the production system through the gunbarrel or lease tank. If the water/oil ratio of the fluid is comparatively low almost complete freedom from corrosion may be obtained. If the water/oil ratio rises above 3 : 1 the resulting corrosion rate depends largely upon the presence of paraffin and the exact composition of the brine. Strainers should be constructed of corrosion 8
resistant material. For severe corrosive conditions either nickel wire wrapped over nickel pipe or galvanized wire wrapped over galvanized pipe is recommended. For liner strings, galvanized pipe is recommended. In tubing failures it has been found that 50 to 75% are due to joint end failures. For tubing, plain carbon, fully normalized, external upset seamless steel is recommended. Most all working barrels are composed of cold drawn steel tubing of special size, possessing a smooth interior. In general, the minimum ball and seat expense seems to be obtained through the use of the better alloy balls and seats and through regrinding the replaced ones for further use. Sucker rod failures have been shown to be due to metal fatigue or a combination of corrosion and fatigue. The practical method of 9
reducing sucker rod failures is to determine for each field the most satisfactory rod to use by setting one or two mixed strings of the various rods and following their service. Tests of various ferrous materials were installed in sulphide bearing salt water lines. After 750 days all the test specimens excepting cement lined wrought iron and cement lined steel had failed. Cement lined pipe can be used for salt water lines, fresh water lines, oil lines handling sulphide bearing oils, tubing for key wells on repressuring projects, gas lines, etc. The normal life of a steel lease tank in a sulphide field is about 18 months. In tests, Al was the only metal capable of fully withstanding H_2S gas which could be used to fabricate lease tanks. However the bottom of the tank is subject to serious corrosion from brine 10
attack. Galvanized steel or galvanized wrought iron tanks will give an added life over black steel sufficient to more than repay the cost of the galvanizing. Vapor tight redwood tanks, for permanent installations, have been found satisfactory. VVK (13)

Prevention of Condenser Corrosion (Bekämpfung von Anfressungen in Kondensatoren). K. ADLOFF. *Die Wärme,* Vol. 58, Mar. 23, 1935, page 195. With an O content of 0.5 mg./liter dezincification of brass tubes takes place. Brass tubes with moderate Zn and Fe contents show a better corrosion resistance, which is furthermore increased by addition of 0.02% As. Comparative corrosion tests in salt water or HCl are advisable. A special brass suited for condenser tubes contains 83% Cu, 0.5% Fe, 0.75% Ni, 1% Al, 1% Si, balance Zn. Its Brinell hardness is 160. The corrosion resistance of some condenser tube materials gave the following results:

hard brass	57.6 Cu, 41 Zn, 1.5 Sn, 0.4 Fe, 0.6 Pb	bad
soft brass	70 Cu, 29 Zn, 1 Sn	fairly good
Al bronze I	87 Cu, 11 Al, 2 Pb	good
Al bronze II	90 Cu, 8 Al, 2 Pb	very good
brass I	80 Cu, 19 Zn, 1 Sn	good
brass II	85 Cu, 14 Zn, 1 Sn	very good

EF (13)

Problems of Coating Technique. Coating of Tubes (Fragen der Anstrichtechnik. Über den Anstrich von Röhren). K. ADLOFF. *Farben Zeitung,* Vol. 40, Apr. 6, 1935, page 349. Pertains to a discussion on the effect of eddy currents on underground pipes. Laboratory corrosion tests must take into account the following 3 factors: (1) current intensity per unit tube surface (with and without protection) at the spot where the current passes into the soil, (2) specific soil resistance and (3) pH value of surrounding soil. EF (13)

Effect of Electrical Drainage on Bituminous Pipe Coatings. ARTHUR B ALLYNE. *Gas Age Record,* Vol. 73, Apr. 14, 1934, pages 347-350. Tests were carried out to determine the negative potential that can be applied to a pipe line without damaging the protective coating. Coal tar and asphalt coated specimens were buried in wet soil and cathodic protection applied. Conclusions are as follows. Asphaltic coatings appear to lose their bond rapidly in the vicinity of bare metal spots on a pipe buried in the soil. This applies when no electrical protection is used as well as when the samples were kept at 0.3 and 4.3 volts below soil potential. Coal tar coatings lost their bond, within the limits of the series of tests, when the samples were kept at 4.3 volts below soil potential but did not behave in this manner when kept at 0.0 or 0.3 volts below soil potential. When the coated specimens were subjected to a potential of 4.3 volts below the soil potential both asphalt and coal tar samples lost their bond, blistered and were pushed from the metal surface. With the coal tar samples at 0.3 volts below the soil potential there seemed to be no greater breakdown of the coating than occurred when no electrical drainage was used. With asphalt samples, a slightly greater loss of bond occurred when they were held at 0.3 volts below soil potential than when no voltage was applied. The electrical resistance of both coal tar and asphalt coatings decreases when buried in soils and seems to be independent of whether or not the pipe is cathodically protected. The results were the same for the two soils used in the tests. The asphalt coated samples that were primed before coating suffered a greater loss of bond than those that were not primed, the primer adhering to the coating, and not the pipe. The primed coal tar coated ones behaved no differently from the unprimed. VVK (13)

14. APPLICATION OF METALS AND ALLOYS

Metals in the Food Industry. N. D. SYLVESTER. *Journal Society of Chemical Industry*, Vol. 54, Mar. 29, 1935, pages 279-283. Suitability of metals for processing and preservation of food is based on the following considerations: (1) effect of metal on the food; (2) maximum allowable metal contamination; (3) effect of food on the metal (taste); (4) effect of washing and cleansing solutions (corrosion) on the metal. The metallic contamination of food is of primary consideration and should be reduced to a minimum. The following generalizations are made: Pb, Pb alloys and Pb solders should be strictly avoided; Cu is not serious; Zn and Sn are safe; Ni is said to be non-toxic; Al and Fe, when present in moderate amounts, are harmless. These metals are positively toxic and prohibitive, Pb, As, Sb, Cd. The remainder of the paper discusses the use of special food processing equipment considered safe, such as glass lined vessels, stainless steels, silver, pure Ni, an alloy consisting of 80% Ni, 14% Cr, 6% Fe, and Monel metal. AAA (14)

Large Uses of Steel in Small Ways. No. 288. Oil Brooder Stoves. *Steel*, Vol. 96, June 10, 1935, page 40. One type of stove uses galvanized and black steel sheets, steel angles, hardware screen, cast-Fe, and Cu tubing. MS (14)

Streamlined Train for New England Utilizes Weight-Saving Materials. *Steel*, Vol. 96, May 6, 1935, pages 38-40. Describes construction of "Comet" of New York, New Haven and Hartford Railroad. Al alloy was used for car bodies and frames, cast steel in trucks, and steel in wheels. Welded high tensile steel is used for end sills. Bed-plates of power-plant are of welded steel construction. MS (14)

Experimental Freight Cars Feature Light Alloys. *Iron Age*, Vol. 135, May 2, 1935, pages 38-40; *Steel*, Vol. 96, May 20, 1935, page 34. Describes experimental freight cars of the Baltimore & Ohio R. R. constructed of light metal alloys. The metals used for the body are Cor-ten, "A-W" 70-90 steel, Plykrome, rustless Fe, double-strength steel and Al alloy. Several of the same alloys and Man-ten are used in the underframes and in sills of 2 of the cars. MS + VSP (14)

New Methods and Materials Give Engineers New Opportunities and New Responsibilities. JOSEPH GESCHELIN. *Automotive Industries*, Vol. 72, Mar. 23, 1935, pages 422-423. New metallurgical materials for automobile manufacture include a great variety of alloy steels, new engine bearing materials—high leaded Cu, Cd base, and Satco Pb base alloys—permitting higher engine speeds and greater bearing loads, light alloys of Al and Mg for weight reduction, high strength brass and Zn alloy die castings and machinable grades of stainless steel. A survey is given of present tendencies in production methods including surface broaching, machining, shot and heavy duty welding and plating finishes. BWG (14)

Fabrication of Steel for Use in Elements of Alkaline Storage Batteries. L. E. BROWNE. *Steel*, Vol. 96, Feb. 4, 1935, pages 30-33. Describes methods and organization of the Edison Storage Battery Division, Thomas A. Edison, Inc. Consumes annually 1500 tons of hot-rolled low-C steel sheets and strip, 750 tons of low-C bar stock, 300 tons of Ni for positive tube cells, and 375 tons of high-grade Swedish Fe for FeO for negative pocket cells. All steel parts are Ni plated with automatic equipment and are annealed. There are 1534 such parts in a standard cell. Strip is cold rolled on a 1-stand automatic mill to the required thickness, perforated, ground, cleaned, Ni plated, and annealed. Negative pocket is folded into form, while positive tube is wound spirally into form. Ni flake is produced by dipping revolving cylinders alternately for 23 sec. in a Ni bath, and about 7 sec. in a Cu bath, with a H_2O bath between each dip. A film of Ni 0.00004 in. thick is deposited. Cylinders are automatically dipped 125 times in each of the metal baths. Sheets are stripped from cylinders, cut into $\frac{1}{16}''$ squares, and the Cu dissolved out, leaving pure Ni. This is washed, dried, screened, and loaded into the positive tubes, which are reinforced by seamless steel rings. MS (14)

Materials Used in Construction of Modern Machine Tool Units. B. K. PRICE. *Steel*, Vol. 96, Feb. 25, 1935, pages 26-28. Deals with materials used by William Sellers & Co., Philadelphia, in construction of machine-tools and with factors involved in their selection. Among metals used are cast-Fe; cast-steel; plain C, cromansil, nitralloy, Cr-Ni, Cr-Ni-Mo, Cr-V, and stainless steels; Al; Cu; and bronzes. MS (14)

Recent Developments in Horizontal Diesel Engines. H. V. SENIOR. *Inspection*, Vol. 5, Oct. 1934, pages 2-40. Paper read before the Institution of Engineering Inspection. Engine design is discussed briefly. Crankshafts are ground from specially heat treated steel. Ni-Cr is used for connecting rods. Ni-alloy cast iron or Ni-Al alloy is used for pistons. White-metal tinned bronze shells are employed for the main and big-end bearings. Liners are made from Ni-alloy cast iron. The breach-end is cast of Ni-alloy cast iron, an especially deep header is used to ensure a close grained homogeneous mixture. It is then heat treated to remove casting strains. Reduction in weight is effected by the use of welded steel crankcases and the employment of Al alloys. Kz (14)

Metals in the Food Industry. *Synthetic & Applied Finishes*, Vol. 5, Feb. 1935, page 277. Paper by N. D. Sylvester before the Society of Chemical Industry, Birmingham, Jan. 1935. The recent development of Cd plating has made a further addition to the list of metals prohibited in food industry. States that the presence of 1 part Cu in 40 million parts of butter has a marked effect on the keeping properties of the butter. Cu in milk develops tallowy flavors. Fe acts similarly but less pronounced. Cu is not a suitable metal for use in the food industry, but tinned Cu has found fairly extensive application in the milk and food industry as a whole. If the quality of Cr plating could be improved to the present reliability of, for example, Ni plating, it should have many applications. Due to the fall in price, the use of Ag has increased and plant lined with Ag sheet was particularly resistant to acetic acid vapors. Al is suitable for use with acid food stuffs, such as fruit, but its lack of resistance to abrasion restricts its use. EF (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Use of Oxide Coatings on Aluminum (Über die Verwendung von Oxydschichten auf Aluminium). W. BIRETT. *Metallwirtschaft*, Vol. 14, Mar. 8, 1935, pages 188-190. Artificial oxide coatings on Al, produced by the Eloxal process, provide resistance to corrosion against mineral salts, weak acids, especially organic acids, weak alkalies and soap solutions, also wear resistance, electrical insulation and heat radiation. Al treated by this process is used in the chemical industry for containers, in washing machines, food containers, refrigerators, and in the form of foil for food wrappers. In architecture it is used for exterior decoration and advertising signs, and for window frames, furniture, and a large number of household articles. It is also used extensively on ships and airplanes, for water pipes, and in the automotive and electrical industry. The heat radiation is increased by painting black, and makes it useful for cooking utensils, radiators and engine cylinders. Due to the hardness of the coating treated Al has much better bearing properties. The oxide film provides a good base for paint. Al properly treated by the Eloxal process can absorb light sensitive chemicals and can be used in the same way as photographic film. After developing good likenesses are obtained which are much more permanent than ordinary photographs and withstand a considerable amount of wear and heat. CEM (14a)

Copper Plumbing (Les Canalisations de Cuivre). H. A. BLUM. *Cuivre et Laiton*, Vol. 8, Apr. 15, 1935, pages 155-159. Advantages of Cu piping, particularly in domestic water distribution and automatic water heating apparatus are discussed. Heat conductivity in comparison with Fe pipe is graphically presented. Ha (14a)

Portable Detector for Radium. L. F. CURTIS. *Bureau of Standards Journal of Research*, Vol. 12, Mar. 1934, pages 379-382. An apparatus with a sensitivity such that 10 mg of Ra produces a deflection of 10 microamperes at a distance of 1 meter is described. WAT (14a)

Tests of Aluminum Foil Insulation. HARHISA INOKUTY, TEISUKE NAGANO, ZYANKITI NAGAOKA & EIZI NOMURA. *Bulletin, Institute of Physical & Chemical Research, Tokyo*. Vol. 13, Jan. 1935, pages 5-19. In Japanese. *Scientific Papers & Abstracts, Institute of Physical & Chemical Research, Tokyo*, Vol. 26, Jan. 1935, pages 1-2. In English. Heat conductivity measurements were made on Al foil of 6.65 μ and 8.33 μ thickness at temperatures ranging from $-20°$ to $+400°$ C. The following formula expresses the heat conductivity of Al foil insulation: $\lambda = 0.0042 + 0.00011\ t_m$, which agrees with previous findings of Schmidt. The effect of corrosion on the insulation ability of Al foil was studied. In order to prevent heat conduction caused by contact of foil and corrosion resulting from electro-chemical action of moisture, an insulation of Al foil and very thin layers of asbestos paper was tested. The plain Al foil insulation method was improved by 10%. WH (14a)

A New Material (Betrachtungen über eine neuen Baustoff). J. F. KESPER. *Obst & Gemüse Verwertungsindustrie*, Vol. 21, Oct. 18, 1934, pages 547-549. Refers to an Al-clad Zn alloy low in Al. By annealing at 150°-300°C. diffusion of Al into the underlying alloy takes place resulting in increased strength. Because of its chemical resistance, utilization in canning industry is recommended. Favorable deep drawing, soldering and polishing properties are emphasized. EF (14a)

Cadmium Copper for Overhead Lines. G. W. PRESTON. *Electrical Review*, Vol. 116, Mar. 15, 1935, pages 372-373. For high-tensile overhead line conductors, Cu alloy containing 0.8-1% Cd has best combination of electrical and mechanical properties of any material available at present. Addition of this small amount of Cd is capable of raising tensile strength of Cu by about 50%, with a reduction in electrical conductivity of the metal in the work-hardened condition of not more than 15%. By adjusting Cd content and degree of cold working, a wide range of mechanical and electrical properties can be obtained. Fatigue tests carried out on a Haigh machine show that range of stress to produce failure of Cd-Cu is more than 25% greater than that required with hard-drawn Cu. Alloy also has superior impact strength. It is harder than ordinary Cu and has a higher annealing temperature, which within limits, increases with increasing Cd content. Its corrosion resistance is of the same order as for Cu itself. MS (14a)

Structures in Aluminium. A. T. PAINTON. *Structural Engineer*, Vol. 13, Feb. 1935, pages 106-113. Paper before the Institution of Structural Engineers, Glasgow, Feb. 1935. In the U. S. A. and Germany long built-up booms of Al for cranes and dragline excavators are in use. It is found that Al booms of any required length can be constructed with a weight saving of 40-50% without sacrifice of strength and rigidity. The capacity of the excavator bucket is increased 20-25%. The low end of the boom is usually of steel since this does not add unduly to the overturning moment. A detailed comparison between a steel and Al boom is made. Utilization of Al for jibs, fire escape ladders (truck-mounted) and travelling cranes is discussed. Tests on 3-10 ton 72 ft. span cranes made of (I) steel, (II) steel-duralumin and (III) duralumin respectively showed that (II) uses 25-30% less power and (III) 50-60% less power than (I). Crane (II) was 15-20% and (III) about 30% faster than (I) on average duty cycles. Al cranes are installed where no provisions for cranes was made in the original building construction. Further examples fully discussed are towing bridge for seaplane testing tank and box girder carrier traverse for rails which doubled the carrying capacity. Although the greatest benefit of lightening is to be expected in plant where motion is essential, Al has been utilized in essentially stationary structures. The most outstanding (American) constructions are discussed at length. Physical properties (tensile strength, compressive strength, elasticity) of Al and Al structural components are fully considered. WH (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

Heavy-Duty Truck Body Has Frame of 4-Inch Hot Forged Stanchions. *Steel*, Vol. 96, Apr. 15, 1935, pages 46-47. Easton Car & Construction Co., Easton, Pa., uses 4" hot-forged cradle beams, which are riveted to 5" undersills, for frame. Results in lighter weight but stronger construction. MS (14b) 1

Steel Dam Faces Consume Large Plate Tonnages—Institute Fosters Trend. *Steel*, Vol. 96, Feb. 11, 1935, pages 46-47. Steel plates are finding increasing use for facing earth- and gravel-filled dams. Penrose-Rosemont dam, Colorado Springs, Colo., has taken 600 tons and El Vado dam, N. Mex. involves 1000 tons. Cu bearing steel is used. Plate wall is welded in the field. MS (14b)

2

Iron vs. Concrete in Very Large Bridges (Voor zeer grote bruggen: ijzer of beton?) *Polytechnisch Weekblad*, Vol. 28, Aug. 23, 1934, page 533. Statements mainly based on a lecture of Henry Lossier before the Society of French Civil Engineers, critically compare the largest steel bridges in the world (U.S.A.) with the largest concrete ones (France). WH (14b)

Molybdenum in Cast Steel (Molybdän im Gussstahl). *Die Metallbörse*, Vol. 25, Feb. 2, 1935, pages 145-146; Feb. 16, 1935, page 210. Mo does not exert a marked effect on the physical properties of cast steel if the C content is below 0.3%. It is utilized in combination with Ni, Mn and V. 0.3-0.8% Mo raises the yield point at 500° C. by 70-100%. Mo steels are particularly suited 3 for case hardening (carburizing). Mo-V steels developed for centrifugal gun castings contain 0.35-0.45 C, 0.5-0.8 Mn, 0.15-0.35 Si, 0.25-0.35 Mo and 0.1 V. V deoxidizes and removes N. Heat treatment of Mo-V and Mo-Ni steels is outlined. Physical properties of a 0.25-0.3 C, 0.6-0.8 Mn, 1.25-1.5 Ni and 0.3-0.35 Mo steel are as follows: tensile strength, 59-63 kg./mm.²; elastic limit, 38.5-42 kg./mm.²; elongation (50 mm.), 22-25%; reduction of area, 45-50%. Two tables are presented which show the analyses and physical properties of 25 different Ni-Mo steels with 0.4-2.0% Ni and 0.2-0.6% Mo (0.1-0.3% C). It is pointed out that 0.1% Mo raises the yield point 1 kg./mm.² and the tensile 4 strength 2 kg./mm.² whereas 0.5% Ni improves the yield point and tensile strength only 2 kg./mm² and 1.9 kg./mm.² respectively. The favorable response to case hardening is stressed. Mo-Mn cast steel with 1-1.75% Mn, 0.2-0.4% Mo and 0.3-0.4% C is very similar to Ni-Mo steel except an increase of the elastic limit for the former. Mo in Mn cast steel exerts a more pronounced effect upon the creep resistance than Cr additions. EF (14b)

Recent Developments in Steel Manufacture for Marine Work. *Journal of Commerce, Shipbuilding & Engineering Edition*, Feb. 1935, pages 1, 3. Developments dealt with are the use of a corrosion resisting 16% Cr, 1% Ni steel; the 5 production on a commercial basis of stainless steel wire and wire cable down to as low as 0.0048"; the use of Cr and Cr-Ni stainless steels containing 0.2-0.3% N; the development of alloy cast irons; the use of Mn-Mo steels for bearings and gears; the centrifugal casting of highly alloyed steel; the replacement of W by Mo in cutting tools; and the chromium-plating of cutting tools and gears. JWD (14b)

Large Uses of Steel in Small Ways. No. 278. Tar Kettles. *Steel*, Vol. 96, Jan. 21, 1935, page 35. Describes construction. 90% of their weight is steel, much of it in the form of sheets. MS (14b)

6

Forged Shaft in River Craft Replaced After 30 Years. EDWIN F. CONE. *Steel*, Vol. 96, Feb. 4, 1935, pages 36, 38. Old hollow-forged Ni steel wheel shaft of rear paddle-wheel steamboat Sprague was recently replaced by a 3.25% Ni steel shaft of the same dimensions. Overall length is 47 ft. 2 in., outside diam., 31 in., inside diam., 21 in., and ends closed down to inside diam. of 10 in. Shipping weight of old shaft is 80,220 lbs. and of new one, 78,305 lbs. Physical properties of old and new steels respectively are tensile strength 81,810 lbs./in.² and 90,000 lbs./in.²; elastic limit, 51,130 lbs./in.² and 54,000 lbs./in.²; elongation, 25.5% and 26.5%; and reduction of area, 49.37% and 57.3%. Vessel recently 7 towed 19 steel barges, loaded with 224,000 barrels of crude oil. MS (14b)

Large Uses of Steel in Small Ways. No. 279. Brake Lining Tools. *Steel*, Vol. 96, Feb. 4, 1935, page 53. Describes a specific type of applier for internal type brake-shoes. Made chiefly of Cd-plated steel. MS (14b)

Large Uses of Steel in Small Ways. No. 280. Bale Ties. *Steel*, Vol. 96, Feb. 18, 1935, page 52. A few years ago annual shipments of bale-ties represented about 50,000 tons of steel. Bale-ties must have requisite tensile 8 strength without undue elongation and be flexible. Lengths are 6-14 ft. and gages, 9-16. Requirements vary in different localities. Hay producing states are largest markets. MS (14b)

Large Uses of Steel in Small Ways. No. 281. Portable Platform Scales. *Steel*, Vol. 96, Mar. 4, 1935, page 58. Modern scales are of all-metal construction. About 150 lb. of Fe and steel are required in the manufacture of this type. Cu-bearing steel sheets are used for pillar, cap, and center panel of platform. Hardened tool and stainless steels are used for pivots and bearings. Beam is made of die-cast Al. Other parts are principally of cast-Fe. MS (14b) 9

Large Uses of Steel in Small Ways. No. 282. Perforated Metal Sheets. *Steel*, Vol. 96, Mar. 18, 1935, page 49. Thousands of tons of steel sheets are consumed annually in production of perforated sheets. Gages customarily used are 20, 22, and 24. Plain C steel is most generally used, but stainless steel is finding increasing application for decorative purposes. Wide variety of designs is available. Practically all perforated steel sheets are given a finish coating. MS (14b)

Large Uses of Steel in Small Ways. No. 283. Wire Rope Clips. *Steel*, Vol. 10 96, Apr. 1, 1935, page 48. Most clips are made of drop-forged steel, about 500 tons of steel being used annually. Malleable Fe castings are used for about 25% of total production. Parts are galvanized before assembling. MS (14b)

Light Welded Steel Frames for Dormitory Buildings. J. B. WELLS. *Engineering News-Record*, Vol. 114, Mar. 14, 1935, pages 380-382. Rigidity, speedy erection, low cost, and low insurance rate were design considerations. CBJ (14b)

Some Reflections on the Use of Stainless Steel in Dairy Equipment. W. J. WACHOWITZ. *Steel*, Vol. 96, Feb. 18, 1935, pages 44, 58. Steel companies should coöperate with each other and with consumer and fabricator. Producers' recommendations for certain types of equipment often vary too much. Fewer failures would occur if only qualified fabricators were furnished material, or if new ones were assisted to produce satisfactory equipment. Designs should be laid out to avoid work strains, and welding rods of certified composition, with proper coating, should be used. MS (14b)

Large Uses of Steel in Small Ways. No. 284. Stapling Machines. *Steel*, Vol. 96, Apr. 15, 1935, page 48. About 200 tons of rolled steel is consumed annually in manufacture of stapling machines and staples. Machines were formerly made largely of die-cast parts. Describes one model, parts of which are stamped and formed from cold-rolled strip and riveted together. MS (14b)

Large Uses of Steel in Small Ways. No. 285. Tractor Chains. *Steel*, Vol. 96, Apr. 29, 1935, page 37. Special type of tire chain for heavy tractors and trucks has the usual rim chain but tread portions of cross chains are replaced by heavy lugs hot formed from ¼" Mo steel plate. Rim and cross chains are formed from ⅜" diam. Mo steel wire. Chains and lugs are case-hardened by carburizing in a rotary gas-furnace. End fasteners are stamped out of heavy steel plate and are frequently brass plated. MS (14b)

Solid Top Is Final Step in Attainment of All-Steel Body. A. H. ALLEN. *Steel*, Vol. 96, Apr. 1, 1935, pages 35-36, 40. Describes fabrication and assembly of tops for Hudson and Terraplane automobiles. 22-gage steel sheets are used. Top is spot welded to rest of body. MS (14b)

All-Steel Toys Manufactured from Salvage Sheet and Strip. A. H. ALLEN. *Steel*, Vol. 96, Apr. 29, 1935, pages 24-27. Describes forming, finishing, and assembling operations at plant of All Metal Products Co., Wyandotte, Mich. MS (14b)

Fabricating Problems Balk Broader Acceptance of 18-8 Piping. ALLAN W. BEATTY & A. REED MCCURDY. *Steel*, Vol. 96, Mar. 4, 1935, pages 38-41. Greater use of light-gage stainless steel tubing is hindered by fabricating difficulties. There is a lack of standard methods, fittings, and valves with which to make a working unit of the tubing. A number of fabricating methods are being used, but, except for types wherein electric welding is employed with a subsequent annealing treatment, all are a compromise with either strength or corrosion resistance. MS (14b)

The Production of Twist Drills and Circular Saws. J. H. BARBER. *Mechanical World & Engineering Record*, Vol. 97, Mar. 8, 1935, page 231. Abstract of a lecture to the Yorkshire Branch of the Institution of Mechanical Engineers. Deals with machining, heat treatment, testing, and inspection of these tools. Kz (14b)

15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

Development of Electrical Purification of Gases (Die Entwicklung der elektrischen Gasreinigung). N. Heymann. *Montanistische Rundschau,* Vol. 27, May 16, 1935, pages 1-14. Gives development of method and describes the various types of precipitators, with wire, plate, and tube electrodes. Installations in Europe alone total over 1,000, with more than 3,000 individual units, and the method is constantly being extended to new fields. Power consumption of an electric precipitator varies from 0.05 to 0.5 kw. hr./1,000 m.^{3} of gas treated, or from 10 to 50% of the power used in a wet or dry mechanical dust settling plant. Under normal conditions an efficiency of 90-98% is attained, with even higher figures when special precautions are taken; 500° C. is generally the upper limit for the temperature of the gases treated. Typical installations in various fields are discussed. In the metallurgical industries 368 installations were operated in 1934, treating an average of 2,800,000 m^3/hr., and recovering 134,000 metric tons annually. Important applications in the chemical industries are for removal of As and other flue dust from roaster gas, precipitation of acid fumes, recovery of phosphoric acid; 445 installations handled 3,800,000 m.^{3} of gas hourly in 1934. Other applications are for purification of gas from coke ovens and coal distillation plants, flue gases in steam power plants, in briquetting plants, cement mills, pigment manufacture, gas producers, etc. BHS (15)

15a. Economic

Substitution of Tin (Zinnersatz. Grenzen und Möglichkeiten). *Die Metallbörse,* Vol. 24, Oct. 13, 1934, page 1308. Statistics on Sn production and consumption. Concludes that the utilization of Sn in automobile and canning industry did not keep abreast with the expansion in these fields and predicts further advances in the recovery of Sn scrap although considerable progress in the secondary Sn metal market was accomplished during the past years. EF (15a)

Copper, Lead, and Zinc Mining in 1934—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M.M.S. 344, Jan. 19, 1935, 3 pages. Production of Cu, Pb and Zn is tabulated by states. Arizona's Cu output gained 56%, Nevada 46%, Utah 16%, New Mexico 4% and Michigan 2% over 1933. Missouri Pb production was up 7%; in Idaho it declined 3% and in Utah 5%. Montana increased Zn output 48%, Tennessee-Virginia 46% and New York 31%. AHE (15a)

Lead Industry in 1934—Advance Summary. H. M. Meyer. *United States Bureau of Mines, Mineral Market Reports* No. M. M. S. 337, Jan. 10, 1935, 2 pages. Refined Pb produced in the U. S. from domestic ores in 1934 was 297,600 tons, 15% higher than 1933. Production from imported ores was 10,700 tons, a 23% decline and only 7% of 1928 production from this source. Apparent domestic consumption increased 21% over 1933. AHE (15a)

15b. Historical

Cannon Specifications in the Revolutionary Days. H. R. Spencer. *Iron Age,* Vol. 135, Feb. 14, 1935, pages 30-31. Describes cannon making in 1794 for
6 the Constitution and other frigates by the owners of furnace Hope. Navy specifications were that cannons should be cast solidly with a sprue head of at least 500 wt. and to be bored out by machinery. It was further specified that any holes found in touch hole, deeper than 20th of an in. should be filled up with beaten Fe. Each cannon was proved by 2 successive discharges. Includes a table giving munitions tolerance of 1794. VSP (15b)

Iron, Prehistoric and Ancient. Harry Craig Richardson. *American Journal of Archaeology,* Vol. 38, Oct.-Dec. 1934, pages 555-583. Condensed in *Steel,* Vol. 96, Feb. 18, 1935, pages 18-20; Feb. 25, 1935, pages 20-22, 78;
7 Mar. 4, 1935, pages 27-28, 74, 76. Includes numerous foot-note references. Discusses primitive Fe industry in Asia and Europe. Quantity of Fe objects found at Hallstatt in upper Austria points to upper Danube valley as place where Fe industry originated, time being 1500-1000 B. C. Not only archaeological evidence, but abundance of good ores in this region, requisite metallurgical knowledge of people, and economic necessity to develop Fe lend support to this theory. From this region, knowledge of working and use of Fe spread eastward to Asia Minor. Late Iron Age, or La Tène, extending from 500 B. C.—1 A. D., was confined to Europe north of the Alps. Celts spread knowledge of Fe over this territory during the period. Greece did not produce Fe but imported it and
8 acquired considerable facility in working it. Villanovan invaders introduced Fe into Italy. Meteoric Fe was also used by primitive man. Deals also with processes of making and working the metal. MS (15b)

Diamond Dies. *Wire & Wire Products,* Vol. 10, May 1935, pages 194-195, 202-204. A history of the development and manufacture of the diamond die is given. Diamond dies are used still extensively in the drawing of card wire, music wire and other expensive fine wires where failure of the die through rapid wear will cause the loss of a costly product. Ha (15b)

9 **Silver Among the Latins.** John A. Bergman. *The Hormone,* Vol. 8, Mar. 1935, pages 49-56. Ancient literature statements (bibliography appended) on history, occurrence, preparation, physical properties, chemical behavior and uses of silver are dealt with at length. EF (15b)

Chemistry as the Handmaid of Archaeology. H. N. Bassett. *Journal Society Chemical Industry,* Vol. 53, Aug. 31, 1934, pages 736-741. Review of the uses of metals in antiquity. VVK (15b)

The Development of the Coreless Induction Furnace. G. H. Clamer. *Metals
10 & Alloys,* Vol. 6, May 1935, pages 119-124, 133. 77 references. Describes the development of the coreless induction furnace, the present state of this art and the advantages of this source of heat. WLC (15b)

Twenty-Five Years of Physical Metallurgy. J. M. Robertson. *Iron & Coal Trades Review,* Vol. 130, May 3, 1935, pages 747-748. Practical results of progress in the physical metallurgy of iron and steel are reviewed, with particular consideration of alloy steels and metallographic developments. Ha (15b)

Vanadium in Steel Castings

Treatise by Jerome Strauss, reprinted from Transactions of the American Foundrymen's Association. Illustrated. Vanadium Corp. of America, 120 Broadway, New York, N. Y. (A 405)

Spencer Turbo-Compressors

This bulletin which has illustrations of the complete range of sizes of this equipment also contains these new items: "Midget" Turbo for individual mounting, a single-stage line which effects new economies and Gas-Tight Turbos for acid and explosive gases. Spencer-Turbine Company, Hartford, Conn. (A 406)

Tubing Weight Tables

"Master Weight Tables" for round steel tubing have been issued in a booklet. All gages, wall thicknesses and diameters are given in both common fractions and decimal equivalents. Timken Steel & Tube Co., Canton, Ohio. (A 407)

Ampco Metal

Engineering Data Sheet No. 18 is devoted to the principal Ampco alloys. Ampco Metal, Inc., Milwaukee, Wis. (A 408)

Electric Furnaces

Catalog No. 22 discusses the melting principle of this company's furnaces. An attractive feature is the extremely low power consumption of these furnaces. The Ajax Metal Company, Electric Furnace Div., 46 Richmond St., Philadelphia, Pa. (A 409)

Handiplater

A colorful leaflet is devoted to the new Udylite Handiplater with detachable cylinder which makes it possible to plate cadmium, copper, nickel, tin, zinc, dry and tumble with one machine. Illustrated. The Udylite Company, 1651 East Grand Blvd., Detroit, Mich. (A 410)

TAG Industrial Thermometers

Catalog No. 1125 contains conveniently arranged listings of the complete Tag line of industrial thermometers, miscellaneous metal and woodback thermometers, hygrometers, U gages, mercurial vacuum gages and mercurial barometers. Illustrated. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y. (A 411)

Alloy Steel Castings

This booklet discusses both alloy steel castings for high stresses and wear resistance, for structural purposes requiring higher physical values than those of plain carbon steel castings, and their stainless alloy steel castings for heat resistance and corrosion resistance at normal and elevated temperatures. Lebanon Steel Foundry, Lebanon, Pa. (A 412)

Foote-Prints

The June, 1935, issue contains some interesting articles, "Chromite" and "Titanium Minerals in Welding Rod Coatings" as well as analyses and specifications of Foote products. Foote Mineral Company, Philadelphia, Pa. (A 413)

Fusion Facts

The July, 1935, issue contains interesting welding articles and also an insert "The Doings of Willie." Illustrated with pretty girls—not the usual subject of a METALS & ALLOYS write-up. Stoody Company, Whittier, Cal. (A 414)

Properties of OFHC Copper

An attractive booklet contains reprints of three papers relating to the above subject. Photographs, diagrams and photomicrographs are used to illustrate these interesting articles. United States Metals Refining Co., 420 Lexington Ave., New York, N. Y. (A 415)

Stainless and Heat Resisting Castings

A colorful brochure is devoted to the chrome nickel alloy castings manufactured by this company. Various applications of these castings are illustrated. Cooper Alloy Foundry Company, Elizabeth, N. J. (A 416)

Stiffness Tester

Bulletin E-10133 is a technical description of Smith Taber Model "A" Precision Stiffness Tester, for the scientific measurement of stiffness and resiliency. Wilson Mechanical Instrument Co., Inc., 383 Concord Ave., New York, N. Y. (A 417)

Refractory Cement

A leaflet pictures the results of a test performed on five brands of refractory cement which were trowelled on a tile and fired at 2700 deg. F. Charles Taylor Sons Company, 710 Burns St., Cincinnati, O. (A 418)

Speed Ultra Cut

Booklet setting forth information on this fast-cutting screw stock. Actual photographs of typical machine parts are shown. Bliss & Laughlin, Inc., Harvey, Ill. (A 419)

Dowmetal "H"

Supplement to Dowmetal Data Book gives information on the sand casting alloy "Dowmetal 'H.'" Dow Chemical Company, Midland, Mich. (A 420)

Industrial Furnaces

A catalog describes, illustrates and gives specifications for this company's annealing furnaces, oil and gas fired heat treating furnaces, rotary forging furnaces, etc. Mahr Mfg. Co., Minneapolis, Minn. (A 421)

Multigrip Floor Plate

This floor plate was designed to provide maximum skid resistance regardless of the way the plate is laid or whether wet or dry. Illinois Steel Co., 208 S. La Salle St., Chicago, Ill. (A 422)

Lectrodryer

A circular from this company is devoted to their "activated Alumina" which can be used in controlled atmosphere annealing of deoxidized sheet, dehumidification of warehouses and special process rooms, industrial and chemical processes and gas conditioning. Pittsburgh Lectrodryer Corp., Pittsburgh, Pa. (A 423)

Ball Bearing Buffers

May be had in either pedestal or bench type. They have large, dust sealed bearings and are guaranteed for one year. Complete list of sizes is included in this leaflet. Illustrated. Baldor Electric Co., 4357 Duncan Ave., St. Louis, Mo. (A 424)

Automatic Temperature Control Pyrometers

Bulletin No. 182 introduces new and improved models of Wilson-Maeulen Potentiometer Control Pyrometers for regulating industrial application of oil, gas and electric heat. Illustrated. The Foxboro Company, Foxboro, Mass. (A 425)

"Nothing Is Impossible to Industry"

Leaflet descriptive of complete units for oil or gas using special composition cast pots. The Campbell-Hausfeld Co., Harrison, O. (A 426)

Stainless Steel

An attractive booklet discusses and illustrates many of the varied uses of this product. It offers a wide range in physical properties with widely varying individual characteristics. The manufacturer claims that in the end it is the least expensive of all corrosion resisting metals. American Stainless Steel Co., Commonwealth Bldg., Pittsburgh, Pa. (A 427)

"Reading Puddle Ball"

Contains an interesting series of articles, "The Story of Genuine Puddled Wrought Iron" as well as interesting stories on its uses. Vivid sketches illustrate the series of articles and photographs are used for the others. The Reading Iron Company, 401 North Broad St., Philadelphia, Pa. (A 428)

Airless Wheelabrator

An airless abrasive cleaning method which, according to the manufacturer, will clean metal surfaces faster, better and at greatly reduced cost is described in this booklet which also contains illustrations and data on several installations of Wheelabrators. American Foundry Equipment Co., Mishawaka, Ind. (A 429)

Ferro-Therm Metal Insulation

An attractive booklet lists and illustrates applications of this new invention which utilizes commercial black steel to produce an insulating material which the manufacturer claims is unsurpassed in efficiency by any insulation now known. American Flange & Manufacturing Co., Inc., 25 Broadway, New York, N. Y. (A 430)

Draw-Cut Machine Tools

Bulletin No. 26 contains information on the subject, illustrating and describing these various tools among which are draw-cut shapers; roll wabble shapers and planers; horizontal, boring, drilling, milling machine and draw-cut traveling head planers; keyway cutters and slotting machines. Morton Mfg. Co., Muskegon Heights, Mich. (A 431)

Spencer Lamps

The Spencer microscope lamps offered in this booklet comprise a group designed to meet a wide range of laboratory requirements. Describes eight lamps, each one illustrated. Spencer Lens Co., Buffalo, N. Y. (A 432)

Cold Drawn Steels

This leaflet states advantages of using Union Drawn Steel. Also new uses to replace castings, forgings and hot rolled stock. Examples are illustrated showing how simply cold drawn parts can be assembled to replace an intricate forging or casting. Union Drawn Steel Co., Massillon, Ohio. (A 433)

Gisholt Lathes—and Ampco Metal

Engineering Data Sheet No. 19 gives useful information on the above subject. Ampco Metal Inc., Milwaukee, Wis. (A 434)

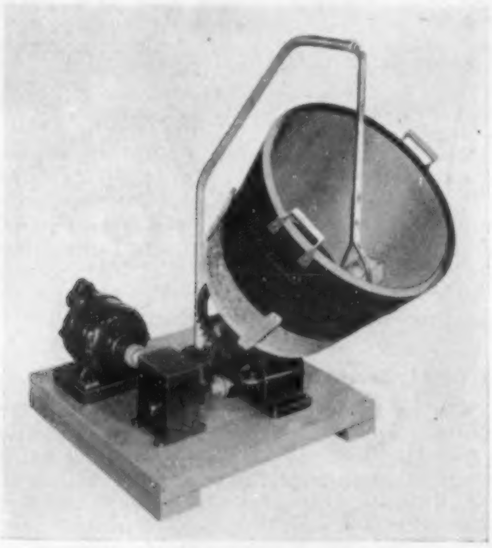
Johnson Bronze Quality Bearings

Describes rolled sheet bronze bushings, plain and graphited, steel-back, Babbitt-lined bearings, bronze-back, Babbitt-lined bearings, flanged bushings and bearings, miscellaneous bronze castings. Johnson Bronze Co., New Castle, Pa. (A 435)

New Equipment and Materials

A Small Barrel Plating Unit

According to the Udylite Co., Detroit, the electroplating industry has been waiting for a small, inexpensive barrel plating unit to handle occasional handfuls of work on the production plating of small quantities of small parts. Usually small loads tie up large plating units and increase the cost of production and it is with difficulty that small quantities can be plated in the large barrel platers.



The Udylite company has introduced a small barrel to meet these conditions and it is believed that it is the first machine of its type to be developed. It will accommodate any plating solution common to barrel plating operations. As illustrated herewith, the cylinder is detachable, making it possible to use the barrel for several plating operations. The cylinder capacity ranges from a handful to 25 lb. The detachable cylinder makes possible the use of any barrel plating solution in the same cylinder. The unit is motor-driven, powered by a 1/6 h.p. motor. Sturdy and compact, it takes up but little room and can be placed out of the way on any available bench. The detachable cylinder provides easy manipulation and operation.

High Yield Casing Now Available

The A. O. Smith Corp. of Milwaukee has announced that it is now ready to supply the new "High-Yield" Casing, of which considerable has been heard in the trade recently. Production has begun on 6⅝ in. and larger sizes. The casing will be made to A.P.I. standard dimensions.

In the opening announcement, the company states that the product, which is cold worked during manufacture, will have an exceptionally high yield point, making it better able to resist collapsing pressures. The process by which this casing is made is patented and said to be an entirely new departure in this form of metal working. The compression yield strength has been raised to closely approach the ultimate tensile strength of the steel.

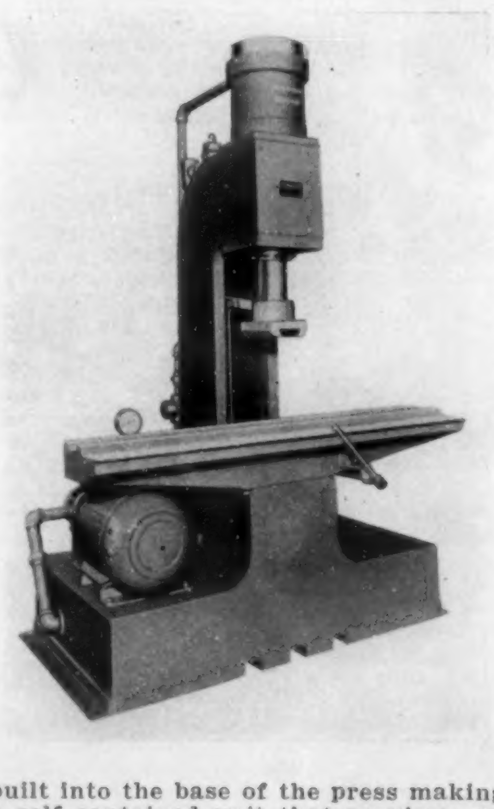
As to its field advantages, the engineers of the A. O. Smith corporation say that, in many cases, lighter strings of casing may be run, and the same resistance to collapse secured, and that the driller will be able to go to greater depths in larger sizes than heretofore. Complete detail as to the practical and scientific characteristics of the casing will be published in a bulletin to be released later.

A Sensitive Straightening Press

A new type 35-ton hydraulic press, especially designed for straightening operations on axle shafts, crankshafts, and similar work requiring accurate straightening, has been developed by Hannifin Mfg. Co., 621-31 South Kolmar Ave., Chicago.

Simplified handling of straightening operations and increased production are claimed to be features from the exclusive design of the control mechanism of this press. A single lever controls the entire operation of the ram, with an extremely sensitive proportional control action. When the control lever is moved in either direction, the ram will move a proportional distance and then stop by automatically bringing the operating valve to neutral. Thus the operator, merely by moving the one operating lever, obtains a ram movement at 35 tons pressure through the exact distance required for the straightening of any piece. An accurate ram movement, either up or down, of as little as 1/16 in. may be obtained. The arc of movement of the control lever is approximately 3 times the ram stroke, providing for very sensitive handling without requiring the development of special skill on the part of the operator.

The hydraulic power unit, with constant delivery type rotary pump, is



built into the base of the press making a self-contained unit that requires approximately 19 sq. ft. of floor space. No separate hydraulic power is required, simplifying the installation and making operation unusually economical.

The ram delivers 35 tons pressure, and may be fitted with any type of fixture required for handling the parts to be straightened. The ram stroke is 6 in. Speeds are—power stroke 53 in. per min.; return stroke 77 in. per min. Dimensions are, table to ram (up) 20 in., center of ram to face of frame 9 in., length of table 70 in., floor to table 36 in., overall height 98 in., base 38½ by 69 in. A variety of special fixtures are available for all types of straightening operations.

Aluminum Mercury Vapor Lamp Fixture

A new lighting unit, utilizing the stand—and 400-watt high intensity mercury vapor lamp, giving unusually high efficiency in the lighting of large industrial plants such as automobile

plants, etc., is offered by the Benjamin Electric Mfg. Co., Des Plaines, Ill. They are particularly adaptable for high mounting in narrow bays.

The reflector is made of oxidized aluminum, natural finish inside; green lacquer outside. These reflectors are made in concentrating and spread types. The former concentrates light below it with most favorable illumination on horizontal surfaces. The spread type provides a wider distribution of light with good illumination on both horizontal and vertical surfaces.

A Fool-Proof Laboratory Stirrer

A fool-proof laboratory stirrer has recently been released. It is not just another mixer but a sturdy, well built accessory most useful for making emulsions; dissolving dyes, gums and resins, waxes and bitumens, pyroxylin, cellulose ethers, casein, glue, gela-

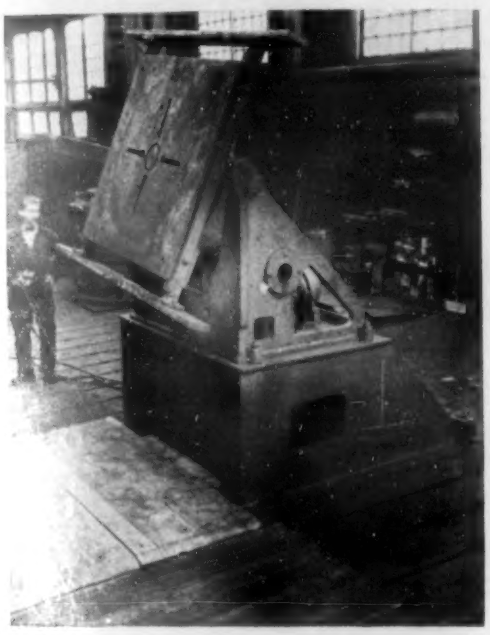
tin, starch, salts; extracting crude drugs and herbs, oil seeds, complex organic materials, etc. Actuated by a shaded pole type motor (110 v., 60 cycle) it will run 24 hr. daily without damage. It is non-sparking and will not be injured by fumes and vapors. The speed may be varied as needed by the rheostat. It fits an ordinary clamp holder or may be screwed to a shelf or wall. The shaft and propeller are

furnished in a chromium plate or Monel. A flexible, 6-ft. rubber covered cord and soft rubber plug are included. It is the lowest priced, durable stirrer now on the market and is offered to the trade by the Chemical Pub. Co. of N. Y., Inc., 175 Fifth Avenue, New York.

New Welding Manipulator Reduces Handling Costs

A welding manipulator, which permits positioning all work to be welded so that fillet welds of correct radius can be made without waste of electrode metal, and which permits savings of 25 to 40 per cent in welding time alone, is announced by the United Engineering & Foundry Co., Pittsburgh. In addition to reducing welding costs and improving the quality of work, this manipulator frees the overhead crane for other duties and eliminates the riggers which are necessary for crane handling.

The welding manipulator is portable



and in general consists of a face plate operated by power supplied by an electric motor of the "Linc-Weld" type manufactured by The Lincoln Electric Co., Cleveland. Operation of the electric motor is controlled by push buttons mounted on an extension cord. By pressure of the proper control button, the face plate can be tilted or rotated to any desired position, the operator riding with the work. Only two handling operations are necessary when using the welding manipulator. These consist merely of placing the work on the face plate for welding and then removing it after welding is completed. Ample provisions for mounting the work are readily available in the face plate.

Capacity of the manipulator is from 5 to 7 tons, depending on the center of gravity of the work being handled. Actual figures covering reduced welding costs by use of the welding manipulator, also a copy of a pamphlet entitled "Management of Welding Costs" can be obtained by application to the United Engineering & Foundry Company, Pittsburgh.

Finishes For Cold Rolled Steel

There are one-coat lacquers on the market so tough and flexible that, when they are roller coated on cold rolled steel, they withstand subsequent piercing, blanking and forming—in fact all fabricating operations—without the least breaking down of the lacquer film.

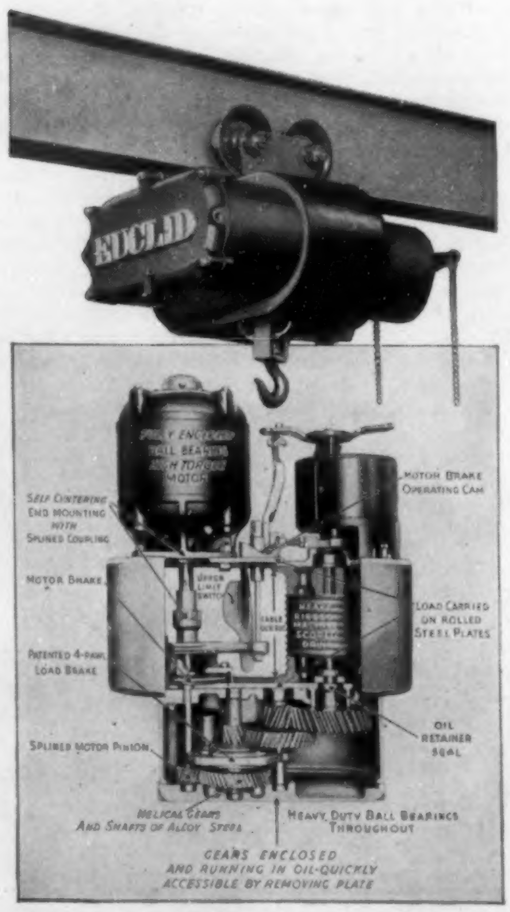
These finishes on the bare, clean metal require no baking, no primer and air dry in regular lacquer time.

On brass and aluminum surfaces these finishes can either be sprayed or dipped, and their adhesion and flexibility are so good on these metals, too, that constant wear and tear won't loosen their tenacious grip. They are marketed by the Roxalin Flexible Lacquer Co., 800 Magnolia Ave., Elizabeth, N. J.

New Euclid Hoist Announced

For the first time in electric hoist construction, a helical or spiral gear drive has been incorporated in the new hoist, just announced by Euclid-Armington Corp., Euclid, Ohio. These spiral gears provide a drive that is claimed more efficient, quieter, stronger and smoother in operation. Two teeth are always in mesh, eliminating the shock load to the teeth encountered in spur gear drives.

The Euclid is also the only hoist using a rolled steel main frame. This construction is lighter yet many times stronger than cast iron. The entire load is carried on steel, eliminating the possibility of accident due to a defective casting. Other advanced features incorporated in this new Euclid hoist include the following: All gears and shafts are alloy steel, heat treated and ground; all shafts rotate on heavy duty ball bearings, providing the highest efficiency; high torque ball bearing motors are used to eliminate motor bearing trouble; all gears are totally enclosed, dust proof and run in oil; all



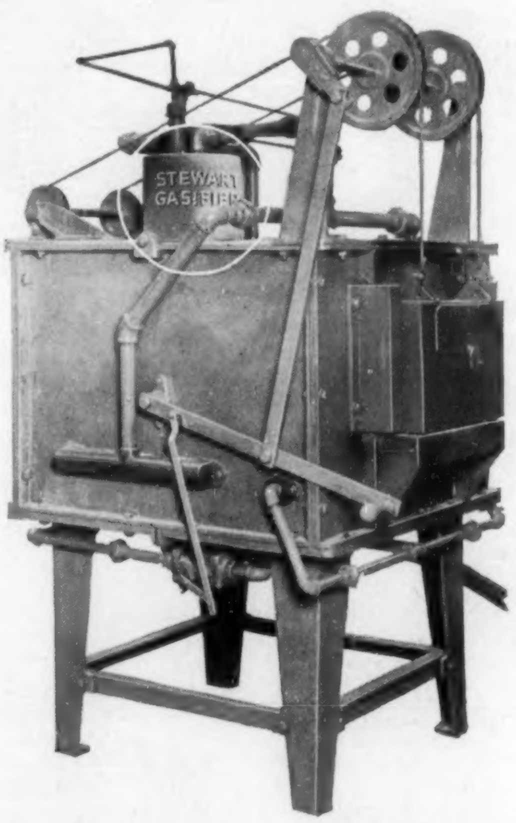
bearings are splash lubricated and all shafts equipped with highest grade oil retainers; a patented load brake of alloy steel assures the utmost safety; and a powerful cam controlled disc brake stops the motor instantly and positively avoids "drifting" of the load.

Fence Manufacturer Adopts Bethanized Wire

The Anchor Post Fence Co., America's first manufacturer of chain link fence, has adopted Bethanized wire, manufactured by the Bethlehem Steel Co., for both fence fabric and barbed wire. According to its manufacturers, this new wire has a protective zinc coating that is 99.997 per cent pure. The coating is applied to the steel base wire by means of a newly developed electrolytic process. In tests, 9 gauge wire has been wound around its own diameter and even bent flat upon itself without cracking or otherwise injuring the coating. Accelerated corrosion tests show that this new wire has greater life than it has previously been possible to obtain with the conventional hot-dip galvanized product.

New Gasifier for Gas-Fired Furnaces

A new gasifier unit for all industrial gas-fired furnaces which reduces gas bills as much as 75 per cent, is now being offered by the Stewart Industrial Furnace Division of the Chicago Flexible Shaft Co., Chicago, Ill. This new



Stewart Gasifier is now in active service in many representative plants throughout the United States. The saving of up to 75 per cent in fuel bills is based by the manufacturer on the record of these installations. The gasifier can be attached to any furnace using gas for fuel. It requires no additional floor space since it rests on the vent of the furnace. No change in the present function of the furnace is necessary. The same burners are used. It operates on the principle of feeding oil through the gasifier, which changes it into gas. It enables the user to buy gas for the low cost of oil yet produces a true gas of high B.t.u. value which goes through the burners like the present gas. It is made in three sizes and can be operated by any standard potentiometer or millivoltmeter type of control.

New Copper Alloy of Unusual Properties

The metallurgical engineering department of P. R. Mallory & Co., Inc., of Indianapolis, Ind., has developed in "Mallory 3 Metal" a material of high electrical conductivity, great mechanical strength and greatly diversified application. Mallory 3 Metal is an alloy consisting predominantly of copper and is claimed to be equal to copper in coefficient of resistivity, coefficient of expansion, modulus of elasticity and corrosion resistance. The electrical conductivity of

forgings and rods of this alloy is rated at 80 to 85 per cent that of copper or better. Sand castings of the metal will have an electrical conductivity of 75 to 85 per cent that of forged copper. The physical properties of this new alloy are equally interesting and a comparison of them with those of copper, brass, bronze and steel is said to be well worth the consideration of any mechanical or electrical engineer.

In commercializing this development, the Mallory organization points to its enviable record of achievement, as it was its special alloys, "Elkonite" and "Elkaloy," which made possible high-speed production in the past few years, on automobiles, streamlined trains, electrical refrigerators, etc., through their use in spot, seam, butt and flash welding machine tips, wheels, and dies.

Mallory 3 Metal may be substituted, with few exceptions, for brass, copper, bronze, or even structural steel. It has already been used extensively for spot welding tips, flash welding dies and seam welding wheels. And castings of the alloy have proved remarkably successful in numerous applications where material of high strength and high conductivity is required.

New General Duty Welding Torch

A new welding torch, known as the Purox No. 35 General Duty Welding Torch, has just been announced by The Linde Air Products Co., 30 East 42nd St., New York. In mechanical details this new piece of equipment is claimed to embody refinements in design and operation that make it outstanding among medium pressure torches. Constructed of extruded brass, Monel metal, and drawn copper, and with silver-soldered tubes, this torch

is rugged and can stand rough treatment. Its range of usefulness makes it equally adaptable to the lightest as well as the heaviest work to be found in any welding shop. It is listed by Underwriters' Laboratories, Inc.

The important features claimed are: The ribbed design of the extruded brass handle reinforces the torch and enables it to be easily gripped. The connections are ferrule type and extend parallel to the axis of the handle. The individual mixers in each welding head are so designed that maximum resistance to flashback is afforded and at the same time the effective range of each size tip is greatly increased. Nine tips perform the duty of 15, the number usually required. The Monel metal seating surfaces are protected, wear-resistant, and easily removable for cleaning or replacement.

A hexagonal socket arrangement permits the welding head to be assembled in the most convenient of six optional positions in relation to the body. This arrangement also prevents injury or scoring of the seating surfaces.

The tips are of hard-drawn copper. They are of the right weight to withstand excessive heat and to maintain perfect balance in the torch as a whole.

The standard Purox No. 21 Cutting Attachment can be used with the new No. 35 torch. The latter is transformed into a light-duty cutting torch having an unusual efficiency of performance given by the new design features of the torch itself.

New Finish Gives Perfect Color Match

The Porcelain Enamel & Mfg. Co. of Baltimore, Md., nationally known manufacturers of porcelain enamels, oxides, opacifiers and cleaners, announces a new series of lead-free cast iron enamels, which are claimed a perfect match in whiteness for sheet iron enamels.

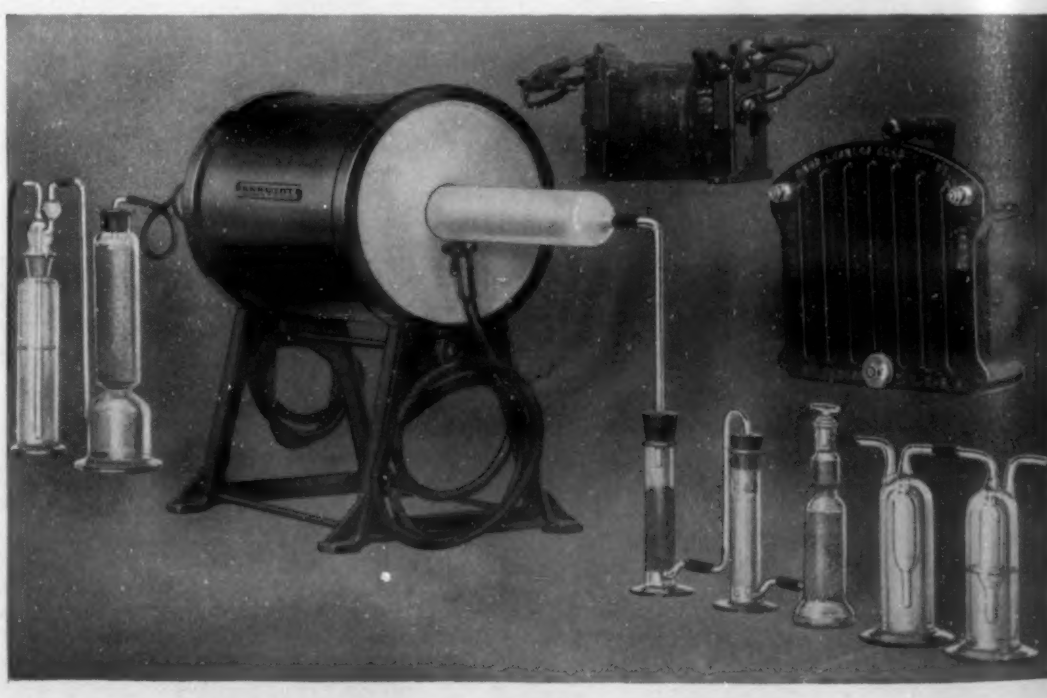
Until the announcement of this new enamel frit, there has always been a distinct difference between the shades of white for porclain enamels fabricated for cast and sheet iron. The porcelain enamel, formerly used on cast iron, was usually yellow or gray and did not have the opacity of sheet iron enamels. These new enamels, it is said, are more workable than the old lead-bearing types as they require no special treatment. This enamel frit has been developed from a series of leadless enamels which have been produced exclusively by Pemco for the last 8 yr. It is believed that manufacturers using porcelain enamel in the production of their products will find this new enamel of decided advantage in eliminating the difficulties often encountered where the finished cast and sheet iron pieces do not match in color.

A Modern Combustion Method

The Chevrolet Motors combustion train is the result of efforts directed toward simplification of purifying, absorptive and protecting units, higher temperatures, automatic control of temperature and larger combustion tubes. It represents a thoroughly modern technique in the determination of total carbon in iron and steel.

Records of routinely operated equipment indicate that, by the use of combustion tubes as large as 2 in. outside diameter, complete combustion of the sample is accelerated and the life of the combustion tube may be multiplied as much as 10 times. Both uniformity of duplicate determinations and the life of combustion tubes are improved by the evenness of temperature claimed secured from automatic regulation.

Such changes as have been made from time to time in purifying and absorbing units, whose principal object is to promote ease of assembly, handling and replacement, have been incorporated in the design of the Chevrolet Motors combustion train, which



is a highly efficient and practical outfit for modern metallurgical laboratories.

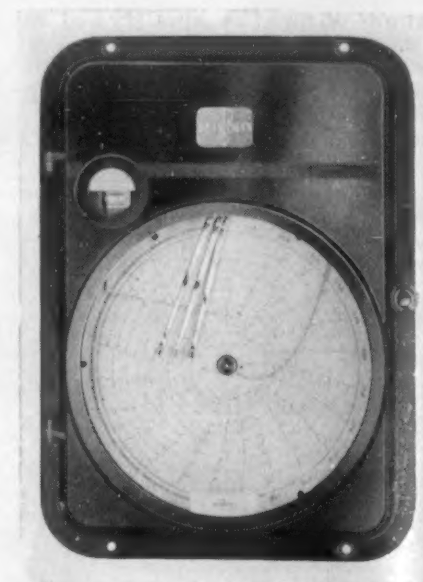
The furnace is the Hoskins type FH, large size, to accommodate combustion tubes with an outside diameter of 2 in., operating on 15 volts and supplied with a transformer to accomplish the step down.

The component parts of the train in order from left to right as illustrated are:

(1). Washing bottle No. 6050 for drying the incoming oxygen through sulfuric acid; (2). drying tower No. 4660 which is filled with potassium hydroxide pellets to remove traces of carbon dioxide from the oxygen; (3). Vitreosil tube No. 3721, outside diameter 2 in., with reduced end; (4). jar No. 3588 to contain granulated zinc for the removal of sulfur; (5). a second jar No. 3588 to be filled with calcium chloride for drying the carbon dioxide; (6). Miller absorption bulb, No. 112 modified form with broad base to be filled with Ascarite for the absorption and weighing of carbon dioxide; (7). washing bottle No. 3578 which acts as an empty protective trap; (8). a second washing bottle No. 3578 to be filled with water for observation of emergent gas flow rate.

Flow Meter Announced by Bristol

Employing the widely accepted orifice and mercury manometer system of flow measurement, the new instrument recently announced by The Bristol Co.,



Waterbury, Conn., is claimed to meet the needs of industry for a rugged, accurate and reasonably-priced mechanical flow meter. It is designed to give precision measurement under severe field conditions. According to the manufacturer, the following are some of the features:

Meter body is of forged steel; small changes in mercury volume incidental to capillarity and adhesion do not affect accuracy; unlike gears or chains, the long float lever arm connecting the large powerful float to the pen arm assures both hair-line sensitivity without jumping and sustained accuracy; connections are welded or mechanical and parts are counter-balanced; working parts permit cleaning without danger of disturbing calibration; hardened stainless steel stuffing box is lapped to the shaft; different ranges of

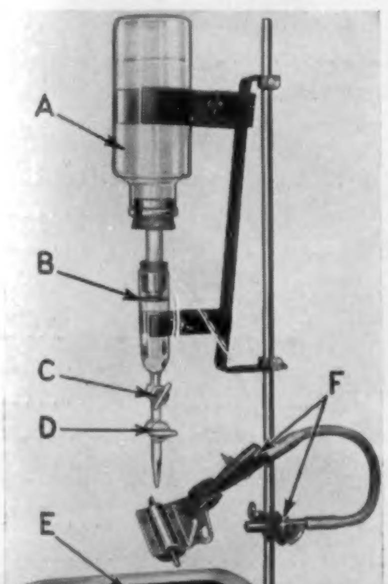
operation are made possible by changing either the size of the orifice, the high pressure leg of the manometer, or both; integrator is positive in action, and is so designed as to eliminate the need for friction contacts and friction clutches; check valves, operating by gravity, prevent the loss of mercury; meters are available as indicators, integrators, recorders or controllers; meters are suitable for use with either orifice plates or venturi tubes; with Bristol's Metameter, this new flow meter can be supplied as an electric flow meter for remote reading.

The Chemicrometer Measures Thickness of Electrodeposits

A new method of measuring the thickness of electrodeposits is made available to the electroplating industry in the chemicrometer (chemical micrometer) which is announced by the Plating Products Co., 352 Mulberry St., Newark, N. J. The scheme of operation is known as the "dropping method." It was introduced in England in 1933 and has since been modified and improved in this country by Hull and Strausser.

A standard corrosive solution is allowed to fall upon the plated article under test at a rate of 80 to 120 drops per min. The time required for the deposit to be dissolved is a measure of thickness. In the case of zinc and cadmium, with proper solutions, the factor is taken as 0.0001 in. of thickness for every 10 sec. the plate stands up. The method is applicable only on zinc and cadmium at present.

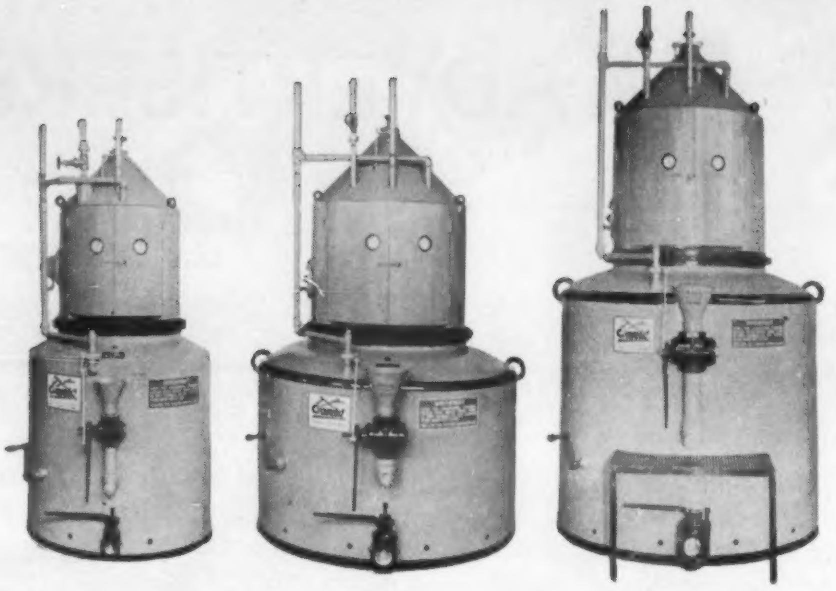
The chemicrometer apparatus for applying the dropping test consists of a reservoir bottle containing the standard text volution arranged above a funnel with two stop-cocks. The correct dropping rate is established with the upper stop-cock which is allowed to remain fixed in that position. The lower stop-cock permits turning the dropping stream full off or full on without changing the adjustment. A



constant level of the liquid is maintained in the funnel, regardless of the quantity in the reservoir. Changes in dropping rate due to variations in head pressure are thus eliminated. The piece to be tested is held in position by means of a flexible clamp.

Medium Pressure Generators

The Linde Air Products Co., 30 East 42nd St., New York, announces a new 3-member family of acetylene generators of the medium pressure type for



stationary service. These generators, designated as Oxweld Type MP-5, have a carbide capacity of 150 lb., 300 lb., and 500 lb. respectively, with acetylene generating capacities ranging from 300 to 1,000 cu. ft. per hr. The three generators provide users of the oxy-acetylene process with a range of choice that should fit practically every need for a stationary generating source of medium pressure acetylene. Except for slight differences in design, making each generator better adapted to the operating conditions for which its size makes it suited, all three generators resemble each other in essential details. These pressure acetylene generators are listed by Underwriters' Laboratories, Inc., and they are the latest automatic stationary devices of their kind.

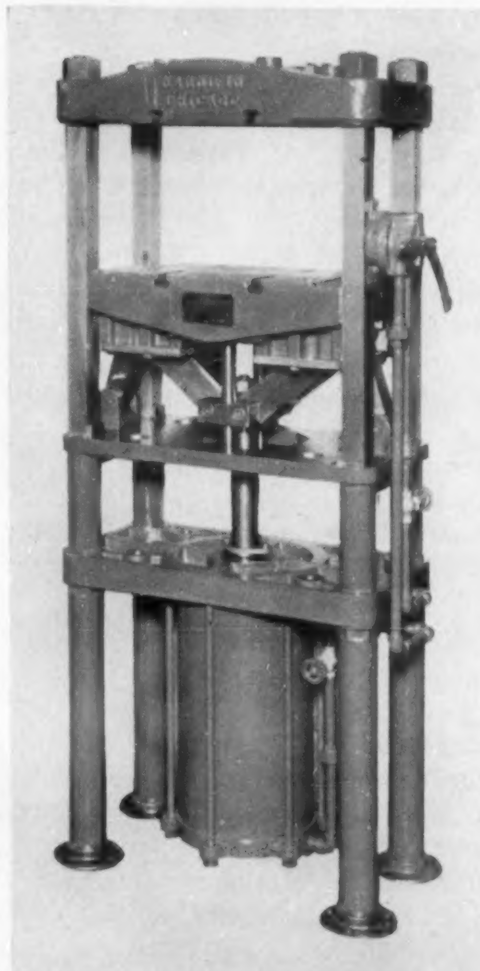
Each generator has all controls protected by a housing which can be padlocked, if desired. This will prevent unauthorized persons from operating the generator or tampering with it. The gravity type feed control unit is self-contained and is bolted to the inside of the upper section of the generator. Withdrawal of acetylene gas in operation operates a diaphragm type feed control which causes a feed valve to open. The diaphragm is sensitive to slight changes in pressure and the carbide is released evenly in just the amount needed to maintain a constant pressure.

Rapid emptying and recharging are made possible by three features. One is a large lubricated plug valve for draining the carbide residue. Another is a water filling valve of similar construction. The third feature is an unusually large carbide charging door. All operating parts are readily accessible for inspection and adjustment. Efficiency of operation and maximum service life are claimed insured through improved design and through the use of strong, durable materials of construction.

An Air-Operated Molding Press

A compact 15 to 18-ton capacity air-operated platen press for plastics and rubber molding operations is announced by Hannafin Mfg. Co., 621-31 South Kolmar Ave., Chicago. The design of this new press provides an advance stroke at 6 times the speed of the pressing stroke. The advance stroke is 5½ in. at 6,000 lb. pressure and the pressing stroke 1½ in. at 30,000 lb. This cycle of operation permits rapid production, and one operator easily handles the steady production of several presses.

This new press is being used for both hot and cold molding, rubber molding, and several types of special molding operations. One prominent manufacturer of electrical specialties has already installed 34 presses of this



type. Speeds and pressures may be regulated to suit individual requirements of any particular molding work. A valuable feature of this press in plastic molding work is the provision for the use of maximum pressure to "break" or separate the molds on the reverse stroke after the pressing operation is completed. An air cushion at the end of the stroke prevents shock.

Since the press is air operated, it is compact and comparatively light in weight. Use of the ordinary shop air supply makes it unnecessary to install hydraulic pumps or special hydraulic power supply for molding work.

Dimensions of the press are: Platen, 17 x 14 in., between columns 22 in., daylight, platen down 17½ in., platen up 10½ in. Advance stroke is 5½ in. at 6,000 lb., power stroke 1½ in. at 30,000 lb. Advance speed is 6 times the pressing speed. Cushioned reversal at full power is provided for separating molds upon completion of the molding period. The capacity of 15 tons is with air line pressure of 80 lb. per sq. in.; 18 tons at 100 lb. per sq. in. The same type press inverted is available for bench mounting.

ADVERTISERS' INDEX

Advertising Office: 330 W. 42nd St., New York, N. Y.

Philip H. Hubbard, Publishing Director

Wm. P. Winsor, Advertising Manager

BRANCH OFFICES

Chicago, Ill., 706 Straus Bldg.
G. E. Cochran

Cleveland, Ohio, 433 Bulkley Bldg.
R. M. Creaghead